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STUDY OF FUNCTIONAL OUTCOME IN PROXIMAL TIBIA FRACTURES FIXATION USING THREE COLUMN CONCEPT

Dissertation submitted to

THE TAMILNADU DR. M. G. R. MEDICAL UNIVERSITY, CHENNAI,

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY IN ORTHOPAEDICS

Under the guidance of

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CHENNAI

2018

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled " **STUDY OF FUNCTIONAL OUTCOME IN PROXIMAL TIBIA FRACTURES USING THREE COLUMN CONCEPT"** is a bonafide and genuine research work carried by me under the guidance of **Prof. Dr. C.ASHOKAN, M.S. (ortho)., D.ortho.,** Associate professor, Department of Orthopaedics, Govt Stanley Medical College, Chennai.

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CERTIFICATE BY THE GUIDE

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Acknowledgement

ACKNOWLEDGEMENT

At the outset. I always thank the god for giving me the strength to perform all my duties.

It indeed gives me immense pleasure to recall the people who have helped me in the completion of dissertation, naming all the people who have helped me in achieving this goal would be impossible, yet I attempt to thank a selected few who have helped me in diverse and important ways.

I acknowledge and express my humble gratitude and sincere thanks to my beloved teacher and guide **Prof. Dr. C.ASHOKAN, M.S.(Ortho)., D.Ortho.,** for his valuable suggestion, fatherly guidance, great care and attention to even small details, that he has so willingly shown in the preparation of this dissertation.

I owe a great deal of respect and gratitude to my professor & Head of the department**, Prof. Dr. T. THOLGAPIYAN D.Ch, M.S (Ortho)** for his whole hearted support and guidance for completion of this dissertation.

I like to express my gratitude and indebtedness to my unit chief **Prof. Dr. K. THANIGAIMANI M.S (Ortho)** for his constant inspiration, extensive encouragement and support, which he rendered in pursuit of my post graduate studies and in preparing this dissertation.

I also express my sincere thanks to my Associate professors

Prof. Dr. S. S. Sukumaran D.Ortho, M. S. (Ortho),

Prof. Dr. K. Mohankumar M.S (Ortho),

Prof. Dr. P. Kosalaraman M. S. (Ortho), D.Ortho

And my registrar **Dr. P. Balakrishnan** D.Ortho

My assistant professor **Dr.R. Ramaraj** M**.S. (**Ortho),

And

Dr. P. Vinod Rajkumar D.ortho, M. S. (Ortho),

Dr. Guruprasath D.ortho, M. S. (Ortho),

Dr. V. Prabhu D.ortho, M. S. (Ortho),

Dr. H. Vardhaman Dhariwal M. S. (Ortho) department of Orthopaedics, Govt Stanley Medical College for their timely suggestions and all round encouragement.

My sincere thanks to the staff especially my post graduate colleagues, Paramedical colleagues and my friends for their whole hearted support.

I am deeply indebted to my parents, brother, sister and friends whose constant encouragement and support helped me to complete my dissertation. Finally I thank my patients who formed the backbone of this study without whom this study would have been impossible.

ETHICAL COMMITTEE APPROVAL

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INSTITUTIONAL ETHICS COMMITTEE

TITLE OF THE WORK : STUDY OF FUNCTIONAL OUTCOME IN PROXIMAL TIBIA FRACTURE FIXATION USING THREE COLOUMN CONCEPT .

PRINCIPAL INVESTIGATOR : DR. YOGESH T.C
DESIGNATION : POST GRAUATE IN MS ORTHO
DEPARTMENT : DEPARTMENT OF ORTHOPAEDICS, GOVT. STANLEY MEDICAL COLLEGE.

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 21.11.2017 at the Council Hall, Stanley Medical College, Chennai-1 at 10am.

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6. You should submit the summary of the work to the ethical committee on completion of the work.

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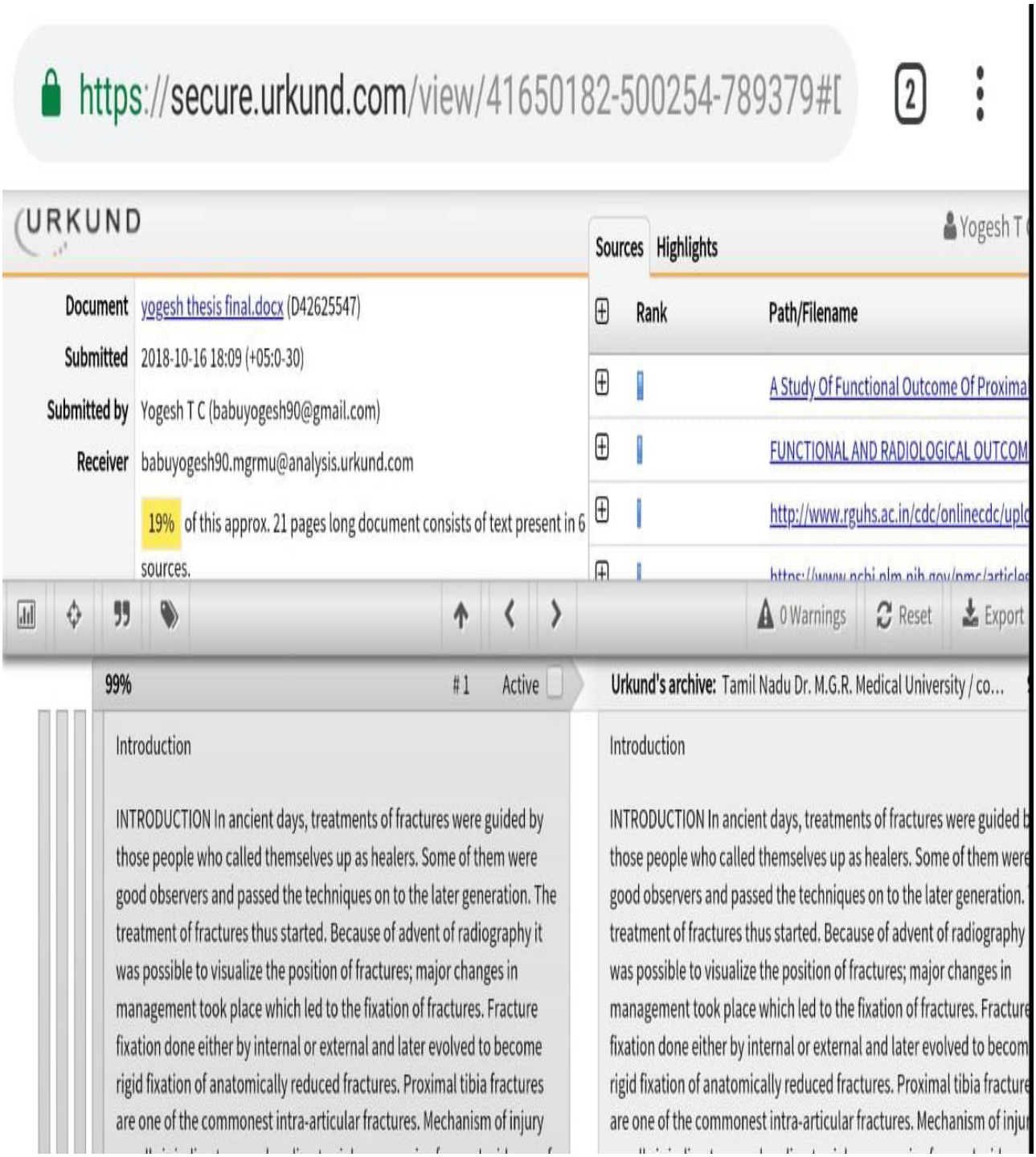

CERTIFICATE

This is to certify that this dissertation work titled "**STUDY OF FUNCTIONAL OUTCOME IN PROXIMAL TIBIA FRACTURE FIXATION USING THREE COLUMN CONCEPT"** of the candidate **Dr. T. C. Yogesh** with registration Number **221612053** for the award of **MASTER OF SURGERY** in the branch **ORTHOPAEDICS.** I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion **84** pages and result shows **19** percentage of plagiarism in the dissertation.

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Introduction

INTRODUCTION

In ancient days, treatments of fractures were guided by those people who called themselves up as healers. Some of them were good observers and passed the techniques on to the later generation. The treatment of fractures thus started. Because of advent of radiography it was possible to visualize the position of fractures; major changes in management took place which led to the fixation of fractures. Fracture fixation done either by internal or external and later evolved to become rigid fixation of anatomically reduced fractures.

Proximal tibia fractures are one of the commonest intra-articular fractures. Mechanism of injury usually is indirect coronal or direct axial compressive forces. Incidence of proximal tibial fractures is 1% of all fractures and 8% of the fractures in elderly. Most injuries affect lateral tibial condyle (55 to 70%) and isolated medial condyle fractures occur in 10 to 23% whereas the involvement of both condyle fractures is found in 10 to 30% of the reported series.[1]

Every different fracture type has its own characteristic morphology and response to the treatment. It is vital to assess the force of injury since high-energy trauma is associated with considerable soft tissue and neurovascular damage. Apart from tibial plateau bony injury, meniscal tear and other ligament injuries of knee need to be assessed.

High velocity injury happened in automobile accidents and increase in incidence of road traffic accidents as a whole is creating an ever-growing

problem. Since man has used to traveling at high speeds in the sitting position with the loading edge composed of flexed hind limbs, when the vehicle in which the subject is traveling stops suddenly, most of the impact is taken at first upon the knee joint the patella, then the tibia and femur in varying proportions of velocity and at various positions which is otherwise called as 'Dash Board Injury'[2]. In other cases the stationary lower limb may be struck by a moving object; this is the most common pedestrian injury, the so called "BUMPER FRACTURE", since the bumper of most vehicles being placed roughly at knee height of the pedestrian.

Due to the evolution of orthopedics, especially in orthopedic trauma, a better understanding of biomechanics, quality of implants, principles of internal fixation, soft tissue care, antibiotics and asepsis have all contributed to the radical change in the treatment of fractures.

Conservative treatment at any age may be complicated by knee stiffness, mal union, and non-union. Open reduction and internal fixation has been advocated using various implants including Buttress plate, cancellous screw, and external fixator etc to achieve good fracture union and optimal knee function.

Thus we have advanced from the conservative approach to internal fixation in fractures as an acceptable mode of treatment. In spite of that, proximal tibia fractures remain challenging because of their number, variety and complexity in management. In spite of many articles, published in the past 50

years that have elaborated the problems of classification and results of various treatments the optimal method of management still remains controversial[3]

Various other modalities of treatment for proximal tibia fractures like hybrid fixation and now locking compression plate fixation using MIPPO technique have also been suggested. Each method of treating the proximal tibia fractures has its own advantages and disadvantages. [4-11] The advancement in the treatment of proximal tibial fracture fixation by the locking compression plates has allowed the treating doctors, the use of minimally invasive technique for unilateral plating with care in handling the soft tissue.[12-21]

In our study we have studied the functional outcome of proximal tibial fractures treated by open reduction and internal fixation using three column concept[22, 23] after a minimum follow up period of 6 months by modified Rasmussen score.[24]

Aims & Objectives

AIMS & OBJECTIVES

- To prospectively study the functional outcome of proximal tibial fractures treated by open reduction and internal fixation using three column concept after a minimum follow up period of 6 months by modified Rasmussen score.
- To study the complications of proximal tibial fractures fixation

Review of Literature

REVIEW OF LITERATURE

- The fundamental principles and various modes of treating proximal tibia fractures have improved over the past 50 years. In earlier days, these fractures were managed conservatively by various non operative techniques and results were published using a variety of conservative management techniques.[4-11]
- Apley corrected the deformity of proximal tibia fractures using skeletal traction and treating it by non operative means. Early knee range of motion was started which was published as an article to have satisfactory results.[25]
- In the year 1890 Lambotte used wires and screws for oblique tibial intra articular fractures [26]
- In the year 1899, british surgeon named Keetley opined in an article on open reduction with wires for lateral tibial condylar fractures.[26]
- Sir Robert Jones[27] stated about the importance of realigning the articular fractures of proximal tibia by open reduction and internal fixation by using bone pegs and long screws. He also stressed the importance of elevating the depressed intra articular fragments from the tibial shaft.
- To replace the articular surface of the severely depressed comminuted fractures of lateral tibial condyle, Wilsons and Jacobs in the year 1952 used the patella.[28]
- In the year 1973 Gothenburg and Rasmussen described a case series of 260 tibial condyle fractures. They stated evidence of instability in

extended knee as the main indication for surgical treatment. They opted to treat 44% of above said patients with closed traction reduction or open reduction and internal fixation using a wire loop or using bone grafts they did open reconstruction of joint surface. Follow up of patients showed 87% had returned to acceptable knee function. [29]

- By the year 1979 two surgeons named Schatzker and McBroom answered that open reduction with near anatomical restoration of articular cartilage of proximal tibia gives best results. In their study of 70 patients they got 78% satisfactory results in the operated group as compared to 58% in the conservatively treated group.[30]
- By 1980's the AO/ASIF group started their work on new plate design to reduce the disadvantages of plating with respect to cortical perfusion. To overcome to negative effects of compression forces on the periosteum which hampers cortical perfusion,a new generation of plates were created. The key to these internal fixators is the locking mechanism of the screws in implant, which provides angular stability and other technical details ensures that compression forces on the bone surface are not necessary to gain stability of bone implant construct and also provides excellent holding force even in severely osteoporotic bone[17-21]
- In the year1984 Blokker et al studied 60 tibial plateau fractures 38 of these fractures were treated by open reduction and internal fixation and 22 treated by closed conservative methods. 75% of the patients had satisfactory results. They observed that the single most important

prognostic factor in predicting the outcome in a patient with tibial plateau fracture was adequacy of reduction of articular surface. The method of achieving the reduction and the length of immobilization period of the knee was not crucial.[31]

- Tscherene and Loben in 1993 examined 190 out of 255 cases of tibial condyle fractures and concluded that open reduction and internal fixation with the objective being, precise reconstruction of the articular surface, stable fragment fixation and allowing early motion and repair of all concomitant lesion, achieved good results even in extremely difficult fractures after open reduction.[32]
- The operative treatment of the tibial plateau fracture using plates and screws is a successful technique. Internal fixation with plates and screws leads to additional trauma and disturbance of blood supply to bone and devitalisation of soft tissues. To overcome these difficulties the recently developed locking compression plating which has limited contact is gaining popularity[17-21,33]
- Cole, Peter A, MD colleagues conducted study on proximal tibial fractures using LISS in which 91 %(total 77 pts.) United without major complications and concluded that LISS provides stable fixation (97%), high rate of union (97%) and low rate of infection (4%) for tibial condyle fractures.[34]
- Egol, Kenneth A et al conducted a study on the treatment of complex proximal tibial fractures using LISS on 38 pts. The cohort of the patients

was evaluated clinically and radiographically for outcomes at a mean 15 months and observed that 36 to 38 (95%) pt's fractures had united at 4 months after surgery with no loss of fixation or infection. Significant loss of range of motion of knee was seen in 5 patients.[35]

- Sommer et al published very good outcome of surgical treatment with LCP in their retrospective study of 90 patients older than 70 years with osteoporosis who were treated using Locking compression plating.[36]
- Partenheimer A et al in yr 2007 concluded that unilateral locked screw plating is a good alternative in treatment of problematic fractures of tibial plateaus than bi column plating that are associated with Soft Tissue Damage and metaphyseal communition.[37]
- In the year 2008, Beck M et al were able to show that tibial LISS is a suitable implant for the treatment of proximal segmental tibia fractures with an acceptable rate of complications.[38]
- Yang et al described that posterior tibial fracture is common in high velocity trauma and CT based three column classification is a much needed one to understand fracture morphology and mechanism of injury which guides appropriate surgical management and improves interobserver reliability[23]
- In 2010 Luo et al described a novel concept based on columns of tibia in the management of tibial plateau fractures, esp. in multiplanar fractures involving posterior column which is often overlooked and concluded that

using posteromedial and anterolateral approaches is the best and safe way to treat complex articular proximal tibial fractures.[22]

ANATOMY

A good understanding and analysis of various anatomical structures around knee and biomechanics of knee is very much essential to pre operatively plan for surgical management, articular surface reconstruction and post operative care to expect the probable complications after injury to proximal tibial region. The tibia is the medial and the larger bone of the leg. It is homologous with the radius of the upper limb.

KNEE JOINT:

It is a large joint of the lower limb. It consists of the relationship between three joint articulations

a) Patello femoral joint(saddle joint)

b) Tibio femoral joint(condylar joint)

c) Tibio fibular joint(condylar joint)[3,4,39]

This triaxial knee joint is very often exposed to external and internal forces in more than five times the body weight. The normal range of knee movements is from 10° of hyperextension to 140° of flexion, 8°-12° of internal and external rotation. The distal femur condyles articulate with the proximal tibial articular surface throughout the knee range of motion. The medial and lateral meniscus supports both articular surfaces and converts this non confirming geometry into a strong joint which is capable of bearing body weight.

The proximal tibia flares out from the shaft to form the lateral and medial tibial condyles. They form joint with the medial and lateral femoral condyles respectively.

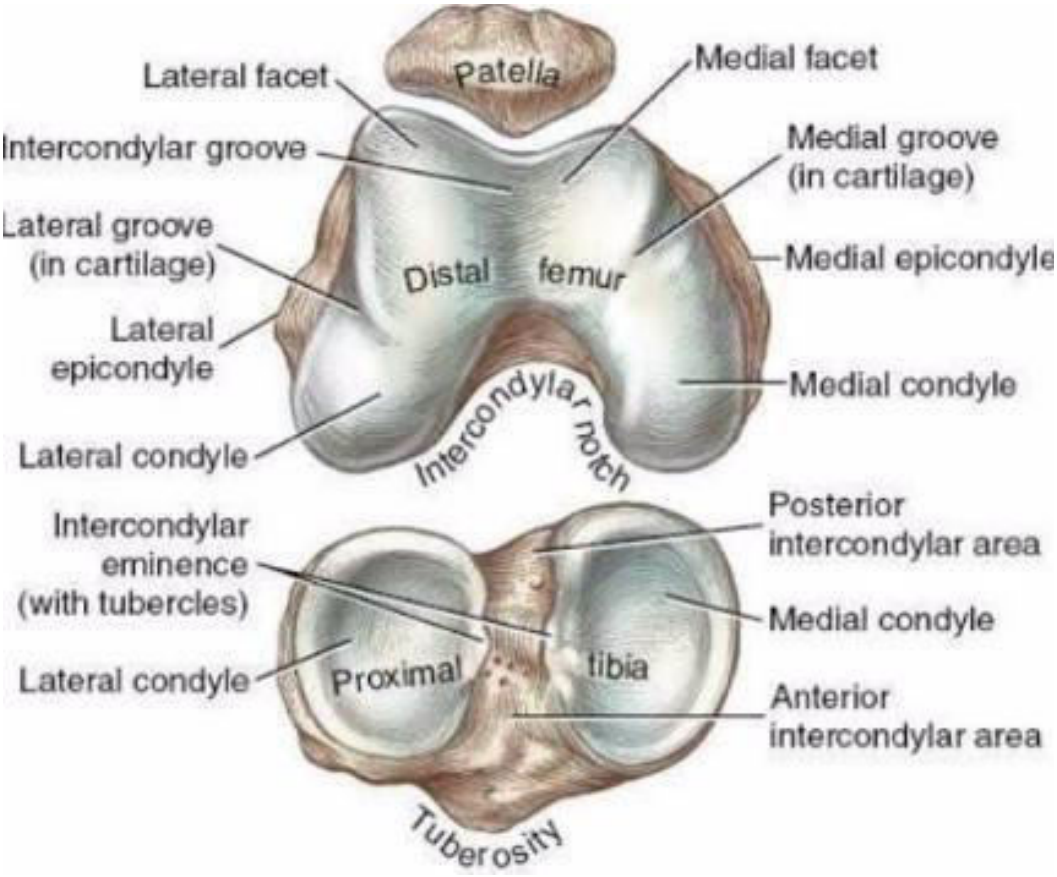


Fig. 1: Bony structures of knee joint

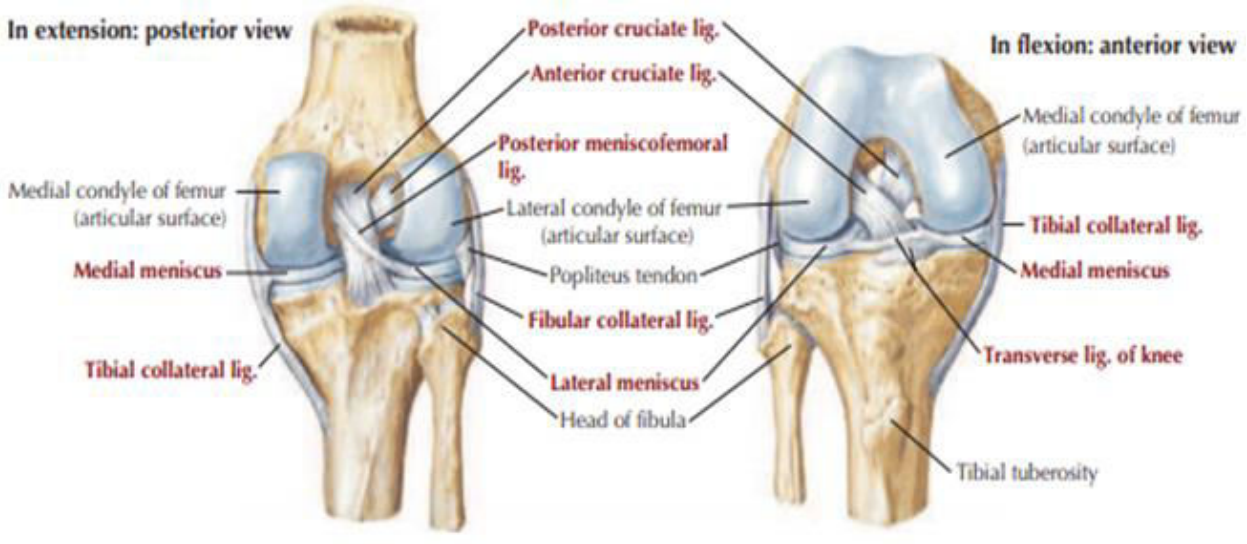


Fig. 2: Knee joint and its ligaments

The articular surface of the proximal tibia is also sloped 7°-10° in an anterior to posterior direction and has a more surface area on the medial plateau compared to lateral tibial plateau. The interspinous insertion of the ACL is protected by medial and lateral tibial spines.

The rotation axis of tibia lies between the position of the mid portion of the tibia and the tibial tubercle (10°-15° of external rotation). [3,4,39]

MEDIAL CONDYLE OF TIBIA:

The medial condyle of tibia is comparatively larger than the lateral condyle of tibia. Bony articular surface of the tibia slope inferiorly approximately by 10 ° from anterior to posterior. Medial tibial condyle's superior surface articulates with the medial femoral condyle, the articular surface of medial tibial condyle is oval. The central part is slightly concave and comes into direct contact with the medial femoral condyle. The peripheral part of the articular surface is flat which is separated from the femoral condyle by the medial meniscus. The lateral margin of the articular surface is raised to cover the medial intercondylar surface. Medial tibial condyle is stronger than lateral tibial condyle because of this lateral condyle fractures are more common.

LATERAL CONDYLE OF TIBIA:

The lateral tibial plateau surface area is smaller and comparatively higher than the medial tibial plateau. Articular surface is convex from anteroposterior as well as from side to side. The fact that the lateral plateau is higher than the medial must be remembered during internal fixation, so that a screw inserted from lateral to medial does not enter the medial articulation. The convexity of

the lateral plateau helps the surgeon to identify it on a lateral, particularly in the sagittal dimension, and more uniformly and gentle concave in both planes. Hyaline cartilage lines articular surface the medial tibial condyle and lateral tibial condyle.

Fibula articulates with lateral tibial condyle through the facet for fibula to form a condylar joint. Fibular facet is flat, circular and directed downwards, backwards and laterally. [3,4,39]

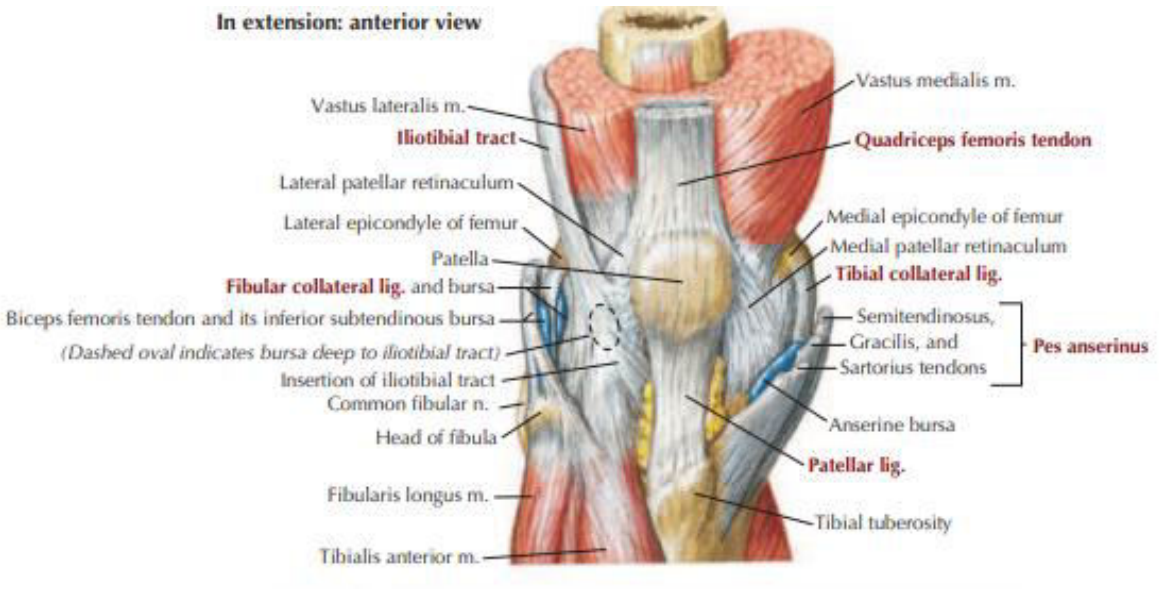


Fig 3: Knee anterior view

INTER CONDYLAR AREA:

The superior articular surface of tibia between the articular surfaces of the two condyles is roughened to form Inter condylar area.

- An elevation termed as "INTERCONDYLAR EMINENCE" is in the middle of the inter condylar region.

➢ It gives attachment to the following structures from anterior to posterior direction.

1) Anterior horn of the medial meniscus.
2) Anterior cruciate ligament(ACL)
3) Anterior horn of lateral meniscus
4) Posterior horn of the lateral meniscus.
5) Posterior horn of the medial meniscus.
6) Posterior cruciate ligament.

TUBEROSITY OF TIBIA:

Tuberosity of tibia lies at the upper end of the tibial shin. It has a smooth upper and a rough lower portion marked by a line or crest. Ligamentum patellae attaches to the upper smooth portion.

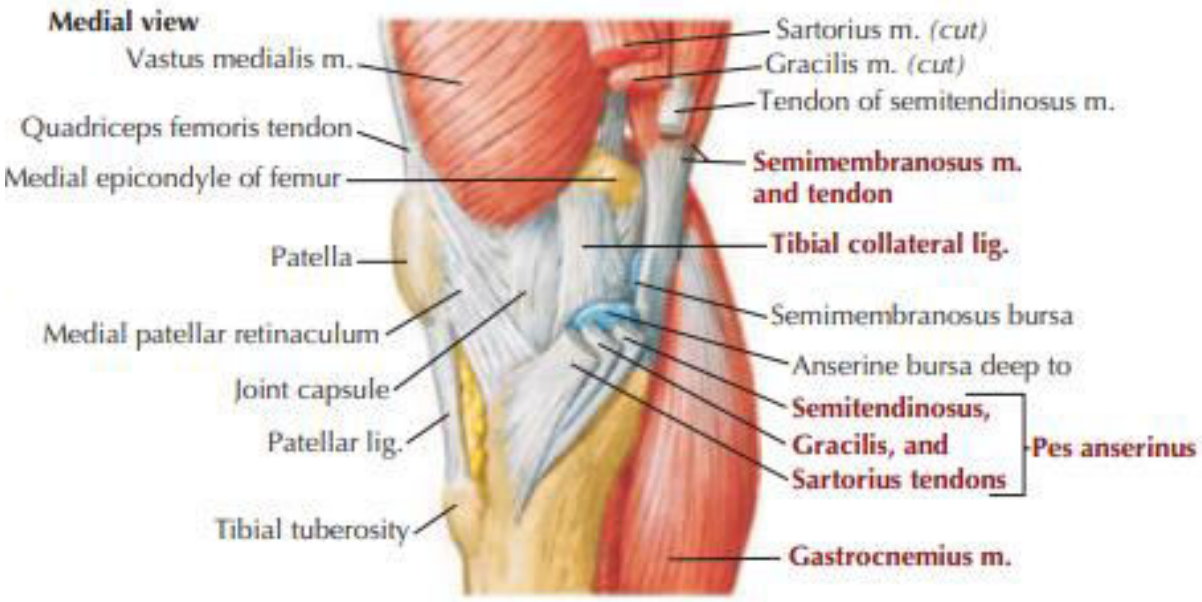


Fig 4: Medial view of Knee

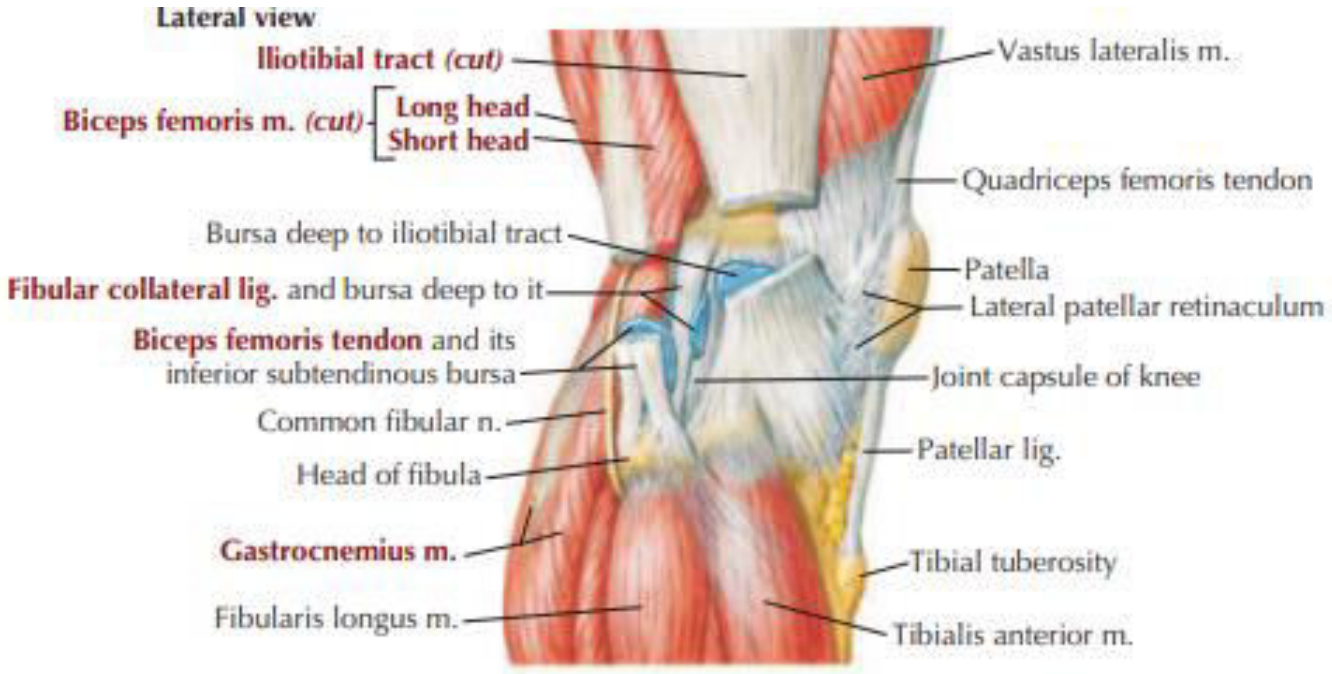


Fig 5: Lateral view of Knee

LIGAMENTS OF KNEE JOINT:

Various ligaments supports knee joint.

1) FIBROUS CAPSULE:

The fibrous capsule is a thin structure and it is deficient on the femoral attachment site above the level of the patella. The capsule is attached to both femur and tibia about 1 cm beyond the articular margin. The capsule through CORONARY LIGAMENTS has weak attachment to the margins of both the menisci.

2) MEDIAL(TIBIAL) COLLATERAL LIGAMENT:

It is a flat, broad, triangular, membranous band attached above to the medial femoral epicondyle just below the adductor tubercle and attached distal to medial articular surface of the tibia.

Phylogenetically the degenerated tendon of the adductor Magnus is represented by tibial collateral ligament.

3) FIBULAR(LATERAL) COLLATERAL LIGAMENT:

Proximally attachment site of LCL is to the lateral epicondyle, below origin of the lateral head of gastronemius and above the insertion of the popliteus tendon; distally attachment site is to the fibular head which is overlapped by the biceps femoris tendon, and protected by bursa. It is separated from the capsule by the inferolateral genicular vessels and nerves.

4) OBLIQUE POPLITEAL LIGAMENT:

It is an expansion of fibrous tissue from the tendon of semimembranosus later blends with the fibrous capsule at the back of the knee joint. It ascends laterally and proximally to the intercondylar fossa. The popliteal artery overlies on the oblique popliteal ligament and it is penetrated by genicular vessels.

5) ARCUATE POPLITEAL LIGAMENT:

It is a 'Y' shaped ligament. It is a thickened band of the posterior capsular fibres. It stars from the fibular head, arches over the popliteus tendon, and is attached to the posterior border of the tibial intercondylar area.

6) CRUCIATE LIGAMENTS:

These are a pair of very strong ligaments connecting the tibia to the femur. Both cruciate ligaments lie within the knee joint capsule, but not within the synovial membrane.

The anterior cruciate ligament is attached to the anterior aspect of the tibial articular surface between the attachments of the anterior horns of the medial and lateral menisci. The ligament ascends posterolaterally twisting on it and is attached to the posteromedial corner of the lateral condyle of femur.

The posterior cruciate ligament is stronger, shorter and less oblique than the anterior cruciate ligament. It is attached to a smooth impression on the posterior part of the tibial intercondylar area, which extends to the upper most part of the posterior surface of the tibia. The posterior cruciate ligament ascends anteromedially and is attached to the anterolateral aspect of the medial condyle of femur. Both cruciate ligaments cross each other like the limbs of the letter X, the anterior ligament lying mainly anterolateral to the posterior ligament.

7) THE MENISCI:

The menisci are crescentric laminae of mainly dense collagenous fibrous tissue that lie on and are attached to the tibial articular surface.

The medial mensicus is almost a semilunar and is broad posteriorly.

The lateral meniscus is 'C' shaped and about $4/5^{th}$ of a circle and with uniform width. Anterior horn of the lateral meniscus is attached in front of the intercondylar eminence of the tibia, behind

the anterior cruciate ligament. The posterior horn of lateral meniscus is attached behind the eminence in front of the posterior horn of the medial meniscus. From the posterior convexity of the lateral meniscus, fibrous bands pass upwards and medially to the medial femoral condyle known as anterior and posterior meniscofemoral ligaments of Humphry and Wrisberg.

The lateral meniscus covers much larger surface of the tibial articular surface than does the medial. The menisci are attached to the periphery of the tibial plateau through meniscotibial ligaments. These structures are important to identify when performing a submeniscial exposure to visualize the articular surface of the tibial plateau. They can be carefully incised in horizontal fashion in submeniscal exposure and must be repaired back to avoid producing an iatrogenic peripheral meniscal detachment.

FUNCTIONS OF MENISCUS:

- Essential for normal function of the knee joint.
- Act as a joint filler
- Prevent capsular and synovial impingement
- Joint lubrication function
- Contributes stability.

8) TRANSVERSE LIGAMENT:

It is a variable band fibrous tissue that connects the anterior horn of the medial meniscus to the anterior convexity of the lateral meniscus.

9) SYNOVIAL MEMBRANE:

It is attached to the articular margins of the femur, tibia and patella and lines the deeper aspect of the capsule, but it is separated from the capsule by the popliteus muscle and the cruciate ligaments. Anteriorly the synovial membrane is separated from the patellar ligament by the infrapatellar pad of fat.

10) LIGAMENTUM PATELLAE:

This ligament is the condensation of the common tendinous portion of quadriceps femoris muscle; the remaining portions of the patellar tendon form medial and lateral patellar retinacula. Proximal attachment to the margin and posterior surface of the apex of patella and distal attatcment to the smooth part of tibial tuberosity. The superficial fibers pass in front of the patella. It is related to the superficial and deep infrapatellar bursae, and to the infrapatellar fat pad.

BLOOD SUPPLY TO KNEE JOINT:

The genicular circulation takes care of the blood supply for all structures of the knee joint. Five arteries form anastomosis around knee joint.

1) The superior genicular artery
2) The medial genicular artery

3) The middle genicular artery

4) The lateral inferior genicular artery

5) Anterior and Posterior recurrent arteries.

This anastomosis supplies bone, capsule and synovial membrane. This anastomosis is situated around the patella, the lower end of femur and upper end of tibia.

1. Superficial part : Lies in the superficial fascia around the patella and the ligamentum patellae

2. Deep part: Over the femur and tibia. It is formed.

Medially by

1) Descending genicular artery

2) Superior medial genicular artery

3) Inferior medial genicular artery

Laterally by

1) Descending branch of lateral circumflex artery

2) Superior lateral genicular artery

3) Inferior lateral genicular artery

4) Anterior tibial recurrent artery

5) Posterior tibial recurrent artery

6) Circumflex fibular artery

Medial side and lateral side arteries are connected by long anastomosis which is interconnected by horizontal anastomoses connections just above and below the patella.

ANASTOMOSIS AROUND KNEE JOINT:

Formed by,

1) Descending genicular artery – A branch of femoral artery
2) Descending branch of lateral circumflex femoral artery
3) Lateral genicular artery – anastomosis connecting the above two arteries
4) Medial genicular artery
5) Lateral inferior genicular artery
6) Medial inferior genicular artery
7) Anterior tibial recurrent artery
8) Circumflex fibular branch of posterior tibial artery

NERVE SUPPLY OF KNEE JOINT:

All three nerves supply the knee joint

1) Nerve to vastus medialis branch of Femoral nerve
2) Genicular branches of Sciatic nerve.
3) Posterior division of obturator nerve. [3,4,39]

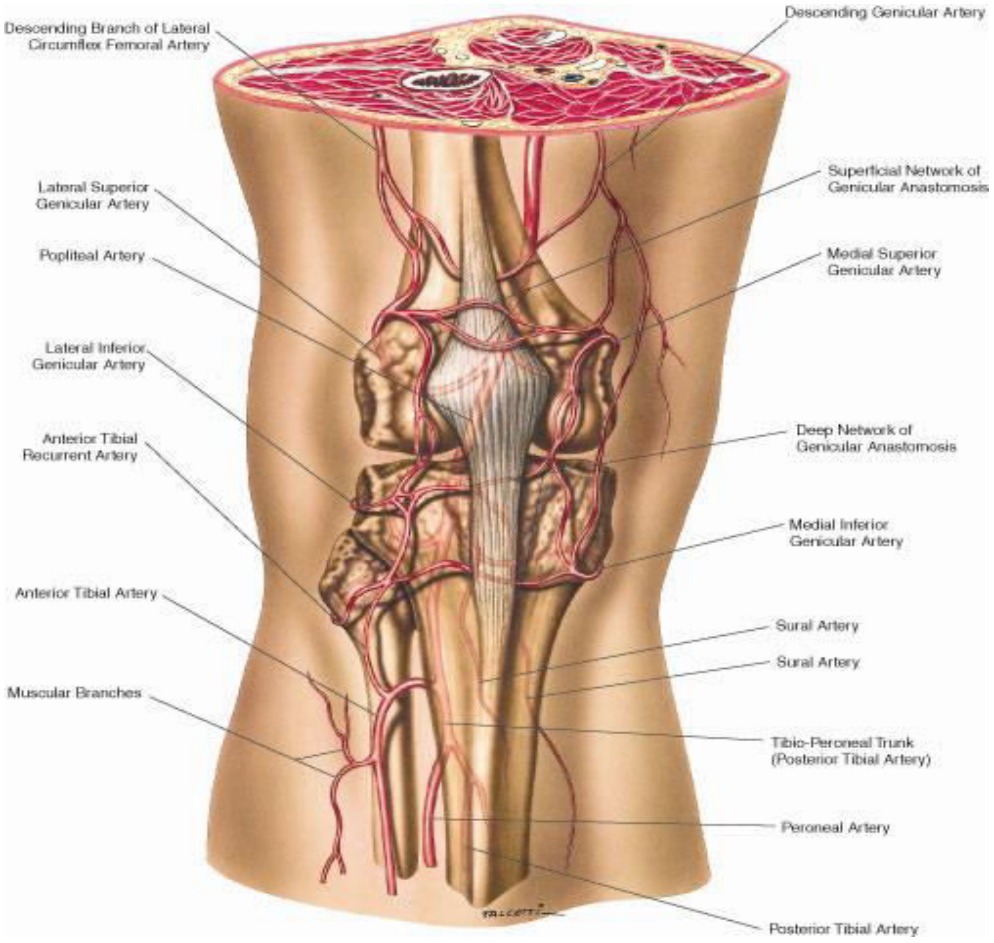


Fig 6: Anastomosis around knee joint.

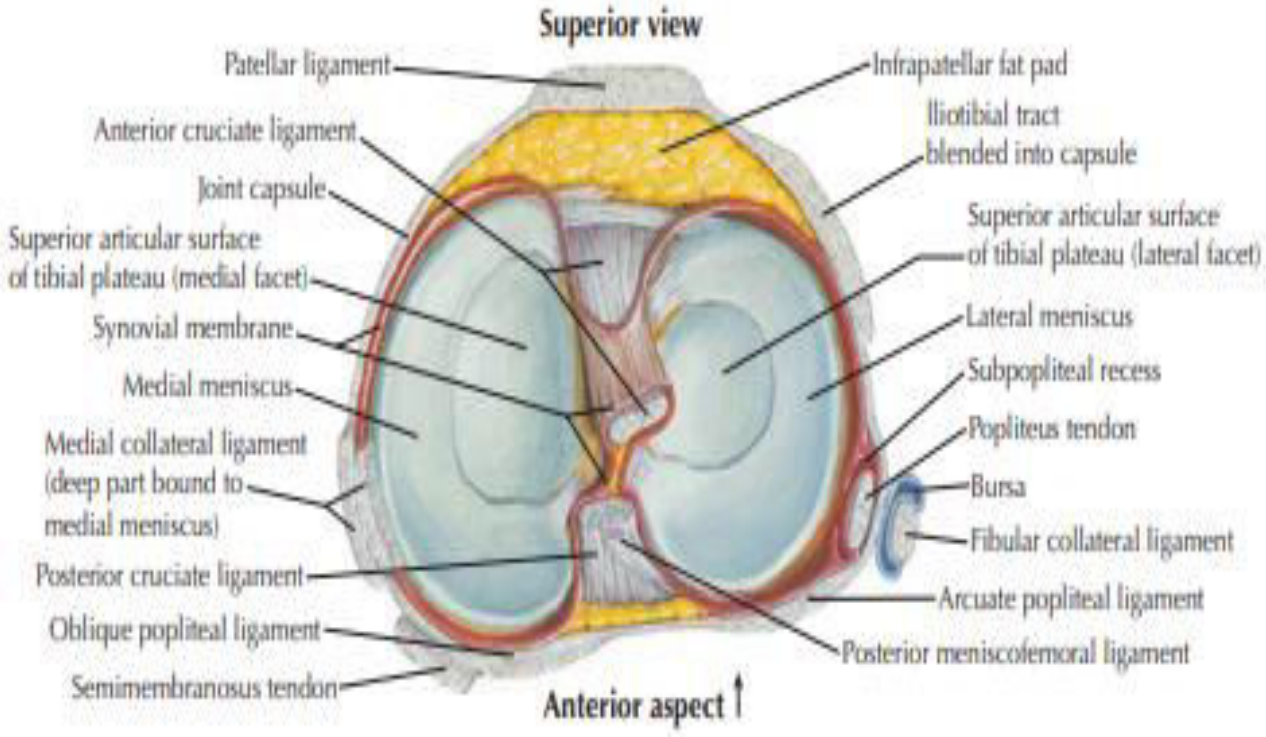


Fig 7: Superior view of knee joint.

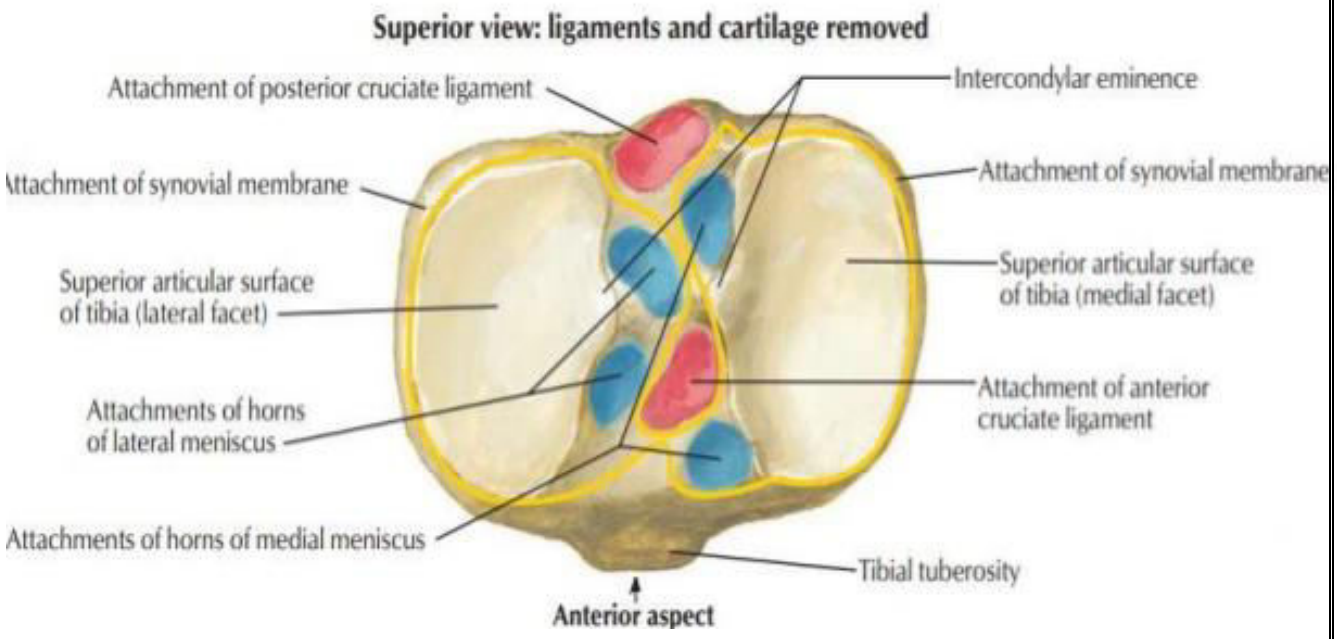


Fig 8: knee joint superior view ligaments removed.

MECHANICS OF KNEE JOINT:

The anatomical axis of the femur and the mechanical axis does not coincide because of line connecting the centre of the hip and the centre of the knee forms 6° - 9° angle with the anatomical axis of the shaft of the femur.

Two types of movements during flexion and extension of the knee joint are produced.

1) Ginglymus
2) Trochoid articulation

The knee joint allows a flexion and extension movement in the sagittal plane and 8-9° of internal rotation and external rotation with the knee is flexed. The complexity of flexion and extension motion is a combination of rocking and gliding. The rocking motion happens in the initial 20° of flexion, after that gliding type movement starts.[40, 41]

The natural deviation outward of the tibia on the femur, at the knee joint produces greater weight bearing stresses on the lateral condyle of femur than the medial. But because the medial femoral condyle is extended further forwards when compared to the lateral condyle, the vertical rotation axis falls close to the medial condyle of femur.

1) Flexion and extension of knee ranges from 0°-140°.
2) Rotation of knee ranges from 5°-25° with individual variation.
3) 5-10° of hyperextension of knee is also possible.[42, 43]

Medial meniscus is more susceptible for tear when compared to lateral meniscus because it has reduced mobility due to its attachments.

- sagittal excursion of tibia over the femur not more than 3-5mm.
- Normal varus and valgus movement at the knee, when extended is not more than 6°-8°.

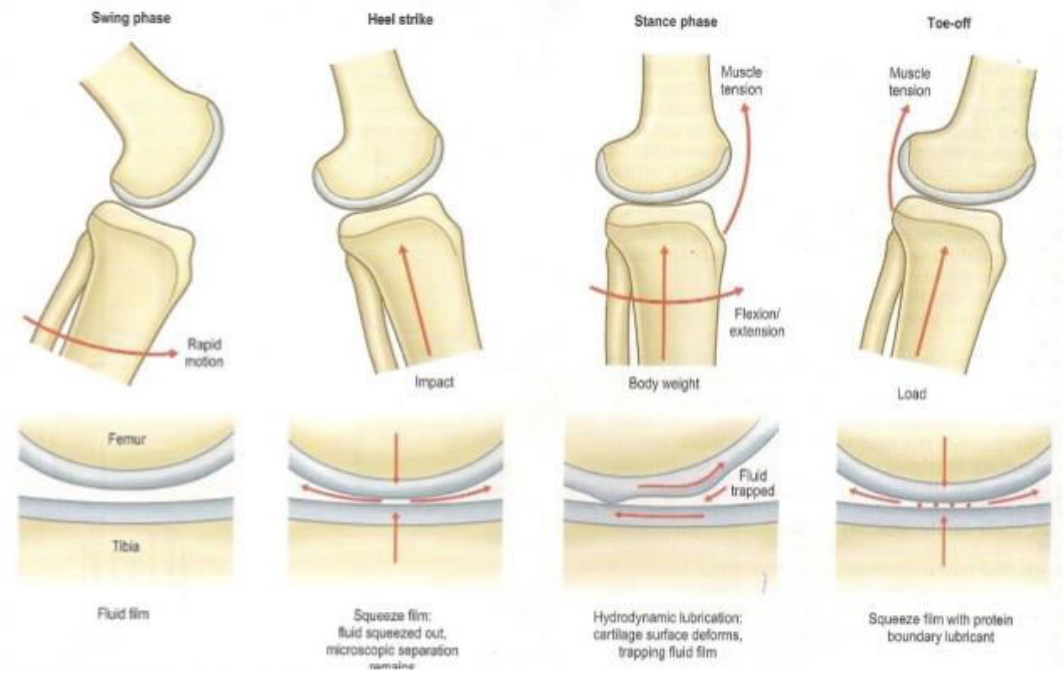


Fig 9: Mechanics of knee joint.

KINETICS: [40-43]

Extension of knee is by the quadriceps mechanism, through the patellar apparatus; the hamstring muscles are mainly responsible for flexion.

1. **Knee stabilizers**:

Ligaments and muscles of the knee play a major role in knee joint stability.

2. **Joint forces**:

Tibiofemoral:

Articular surfaces of femur and tibia are subjected to a loading force which is equal to 3 times the body weight in level walking and up to 4times more while climbing steps. Both menisci also involved in load transmission.

Patellofemoral:

Patella plays a very important role in knee extension by increasing the lever arm. Loads on knee are proportional to the ratio of quadriceps force to knee flexion. The quadriceps acts as an anterior subluxating force at 0-45 degrees range of motion.

3. **Axis**:- [40-43]

- The mechanical axis: - from centre of the femoral head to centre of ankle
- Vertical axis: from centre of gravity to ground
- Anatomic axis: along the long axis of shaft of femur and shaft of tibia.

Relationships:

- Mechanical axis is at three degrees valgus from vertical axis.
- Anatomic axis of femur has seven degrees of valgus from mechanical axis.
- Anatomic axis of tibia is at two to three degrees varus from mechanical axis
- In normal standing phase 75 – 90 % of load is shared on the medial portion of the knee. [40-43]

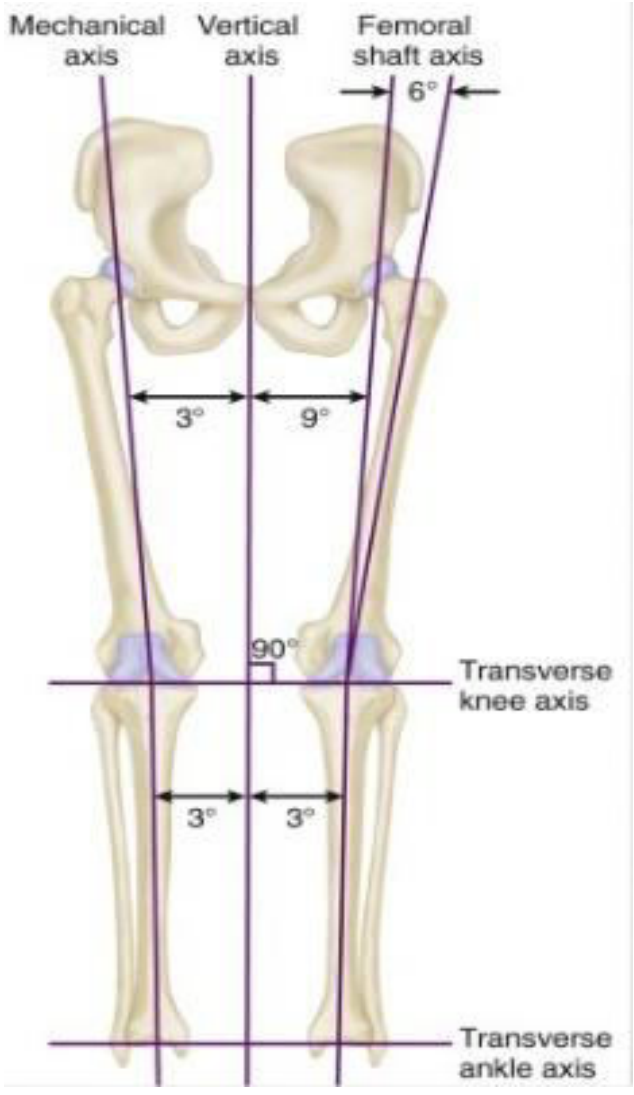


Fig 10: Axis of knee joint.

The proximal aspect of anterior tibia is subcutaneous, while posterior tibia is deep underneath the structures crossing the popliteal fossa, making direct surgical exposures in the posterior tibia is difficult. The anterior tibia is more surgically accessible. The pes tendons (gracilis, sartorius, and semitendinosis) insert on the anteromedial surface of the proximal tibia just below the insertion of the patellar tendon on the tibial tuberocity. Before insertion, these tendons give off fascial expansions to the fascia of the lower leg. The posterior aspect of these pes expansions must be incised and retracted anteriorly during the posteromedial approach for better exposure.

The anterior compartment muscles of the leg, tibialis anterior and extensor digitorum longus, originate from the inferior surface of the lateral condyle of the tibia. The origin must be elevated from the bone to place an anterolateral tibial plate. The medial head of the gastronemius originate from the posterior aspect of the femur just above the posterior aspect of medial femoral condyle. It can be retracted laterally or, if necessary, the origin can be incised and elevated to enhance exposure of the posteromedial and posterior tibial plateau. [3,4,39]

The common peroneal nerve runs below the cover of the biceps femoris muscle and winds around the neck of the fibula posteriorly. It is usually not at risk during most surgery for lateral tibial plateau fractures as long as the surgeon knows the position of the fibula. Posterolateral approach to proximal tibia may be chosen rarely in which case the common peroneal nerve must be

identified and mobilized. The nerve is at risk from direct lateral impact mechanisms and with high-velocity fractures of the tibial plateau, particularly medial tibial plateau fractures which produce varus alignment. [3,4,39]

The popliteal artery rarely gets injured in proximal tibia fractures. However, the trifurcation of the popliteal artery occurs in the area where fracture displacement is likely with certain fracture patterns and the anterior tibial artery is bound at the interosseous membrane and is at particular risk in shaft dissociated patterns. Occult injury to the anterior tibial artery may occur as part of the compartment syndromes usually associated with these fracture patterns.

MECHANISM OF FRACTURE:

Angular forces and compression acting on the knee and axial loading forces lead to failure through the flared tibial condyles on the lateral or medial sides or with straight axial loading on both condyles of tibia.

The articular surface of the lateral condyle of tibia is convex, while that of medial condyle of tibia is concave. It provides greater articular congruity with the medial condyle of femur than on the lateral condyle of femur. This is important when using radiographs and fluoroscopy for diagnosis and surgical treatment because it allows separate analysis of the medial and lateral plateau on the lateral view of the radiographs. The proximal articular surface of tibia slopes in relation to the shaft from the front (which is high), to the back (which is low).

Fractures of the proximal tibia region occur as a result of strong valgus force or varus force along with axial load.

When a patient sustains injury with varus or valgus force along with an axial load at knee joint, the respective femoral condyle impacts both a shearing and a compressive force over the underlying tibial plateau. This frequently results in a split fracture of the condyle, a depressed tibial plateau fracture or both. Isolated split fractures without articular depression are usually in younger adults where dense cancellous bone absorbs the compressive forces on the joint. With aging, the strong cancellous bone gradually becomes weak and sparser and is cannot withstand the compressive forces. With impact loading with velocity, a depressed or split depressed fracture usually happens.

The tibial collateral ligament acts like a hinge or stopper so, the valgus forces drive the lateral femoral condyle into the lateral tibial plateau. The lateral collateral ligament also acts in a same mechanism when varus forces act to cause medial plateau fractures. Due to the evolution of MRI, patients with upper tibial fractures, ligament injuries have been found in a higher percentage of patients. So, they patients may have an associated medial (tibial) collateral ligament or anterior cruciate ligament injury in lateral tibial plateau fracture. The same mechanism causes lateral collateral ligament tear or cruciate ligament tear in fractures of the medial tibial plateau. [40-43]

The location of the proximal tibial fracture depends on the degree of flexion/extension of the knee. However when axial loads exceeds 8000 pounds, explosive severely comminuted fractures are produced. This mechanism is thought to occur clinically when a patient had an accidental fall from a height on the extended knee.

These types of articular fractures may occur also due to motor vehicle accidents, assaults, etc.

1) Older age group patients will have more incidences of depressed proximal tibial articular fractures and split depressed fractures. Younger patients will have more incidences of pure split fractures.
2) Fracture line and the site of depression whether it is anterior, middle or posterior is determined by degree of flexion of knee combined with valgus/varus force and axial loading.
3) Integrity of the collateral ligaments whether it is intact or torn and forces determines the type of fracture.
4) Bicondylar fractures caused by axial loading or axial loading along with varus/valgus stress.
5) High velocity injuries are usually associated with ligament, vascular; nerve injures and associated soft tissue injuries.
6) Direct impact injuries over the proximal one third of tibia can also lead to subcondylar fractures without involving the articular surface. [40-43]

Many factors can in combination to produce various different types of fractures and complications.

Fracture classification is very much important in defining the fracture pattern and to select optimal surgical procedure. Proximal tibial fractures were most commonly treated surgically. Surgical complications were also more common compared to other types of fractures. So, various

modifications have been evolved in surgical techniques of reducing and fixing the fractures over the last three or four decades which aims at reducing the complications following fixation of the proximal tibial fracture.

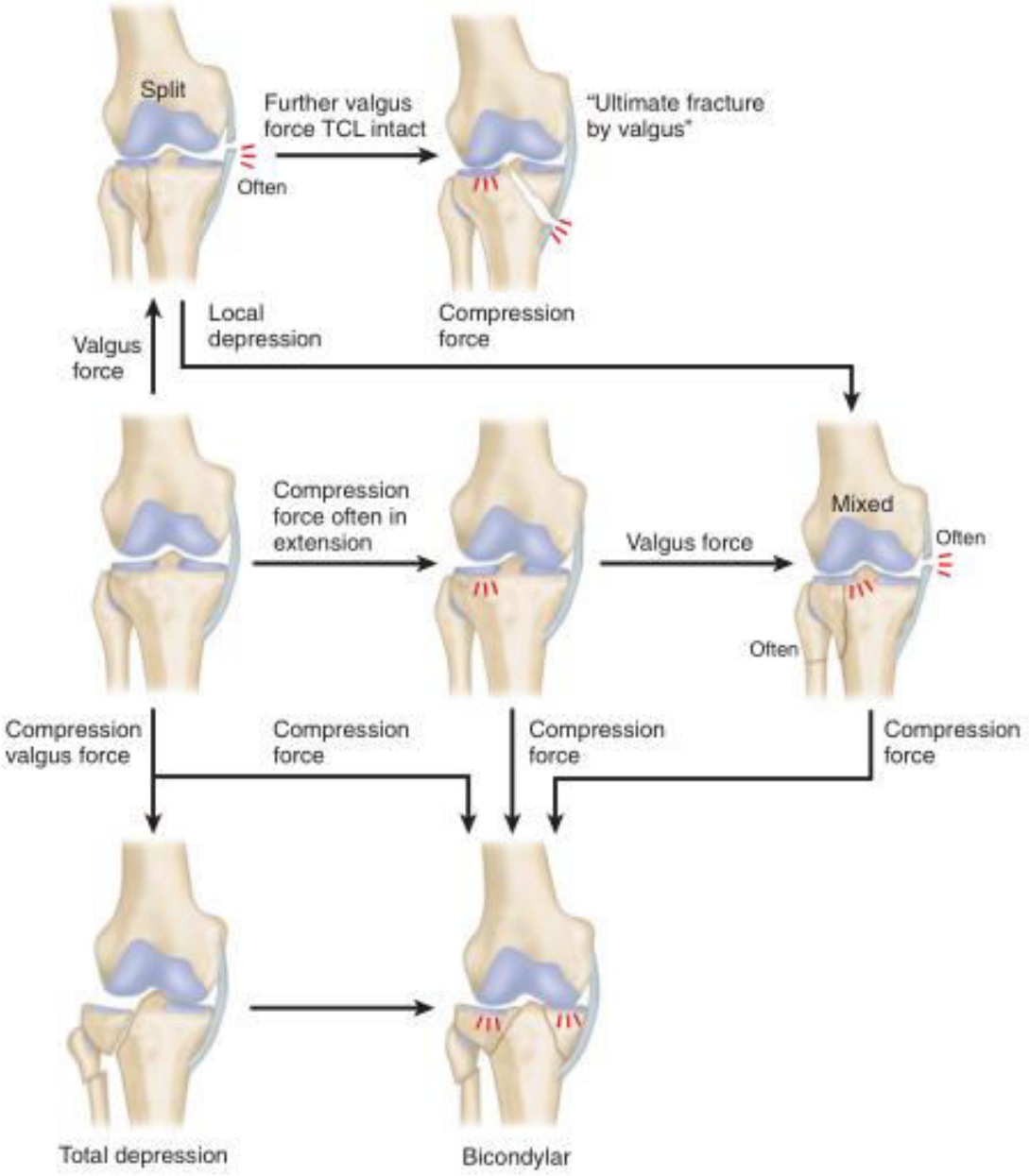


Fig 11: Mechanism of fracture- proximal tibia.

FRACTURE CLASSIFICATION:

I. **SCHATZKERS CLASSIFICATION[30, 44, 47]:** It is based on plain radiograph of the proximal tibia.

Totally six types.

1) Pure lateral tibial condyle split fracture
2) Lateral tibial condyle split with depression
3) Pure central depression
4) Medial tibial condyle fracture
5) Both condyle fracture
6) Both condyle fractures with metaphyseo diaphseal dissociation.

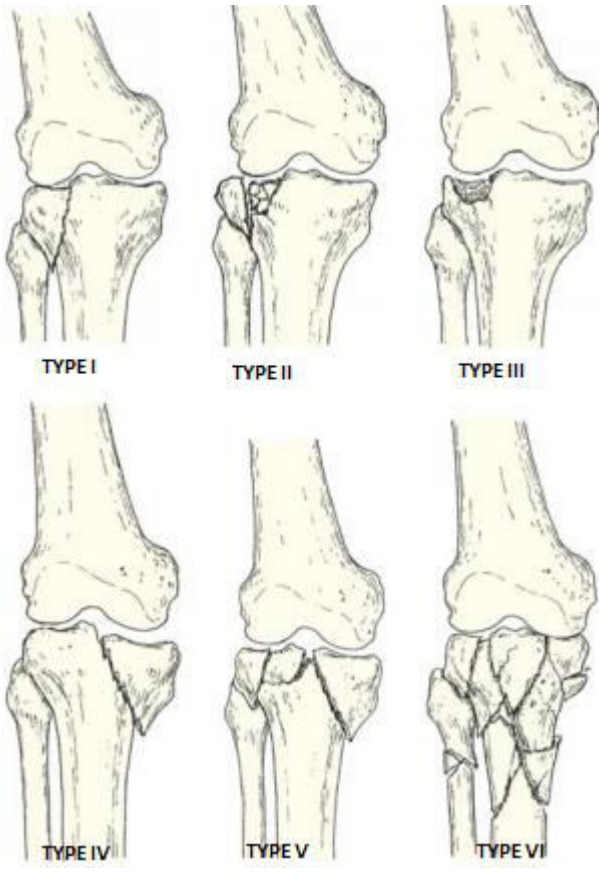


Fig 12: Schatzkers classification.

II HOHL AND MOORES CLASSIFICATION[44, 45]:

A. FRACTURE PATTERN:

TYPE 1: Lateral tibial condyle split fracture.

TYPE 2: Lateral tibial condyle compression fracture.

TYPE 3: Lateral tibial condyle split with compression fracture.

TYPE 4: Total tibial condyle fractures.

TYPE 5: Both condyle fractures of tibia.

B. FRACTURE DISLOCATION PATTERN:

TYPE 1: Coronal split fracture of the tibia with dislocation.

TYPE 2: Entire tibial condyle fracture with dislocation.

TYPE 3: Rim avulsion fracture of the condyle with dislocation.

TYPE 4: Rim compression fracture of the condyle with dislocation.

TYPE 5: Four part fracture of the condyle with dislocation.

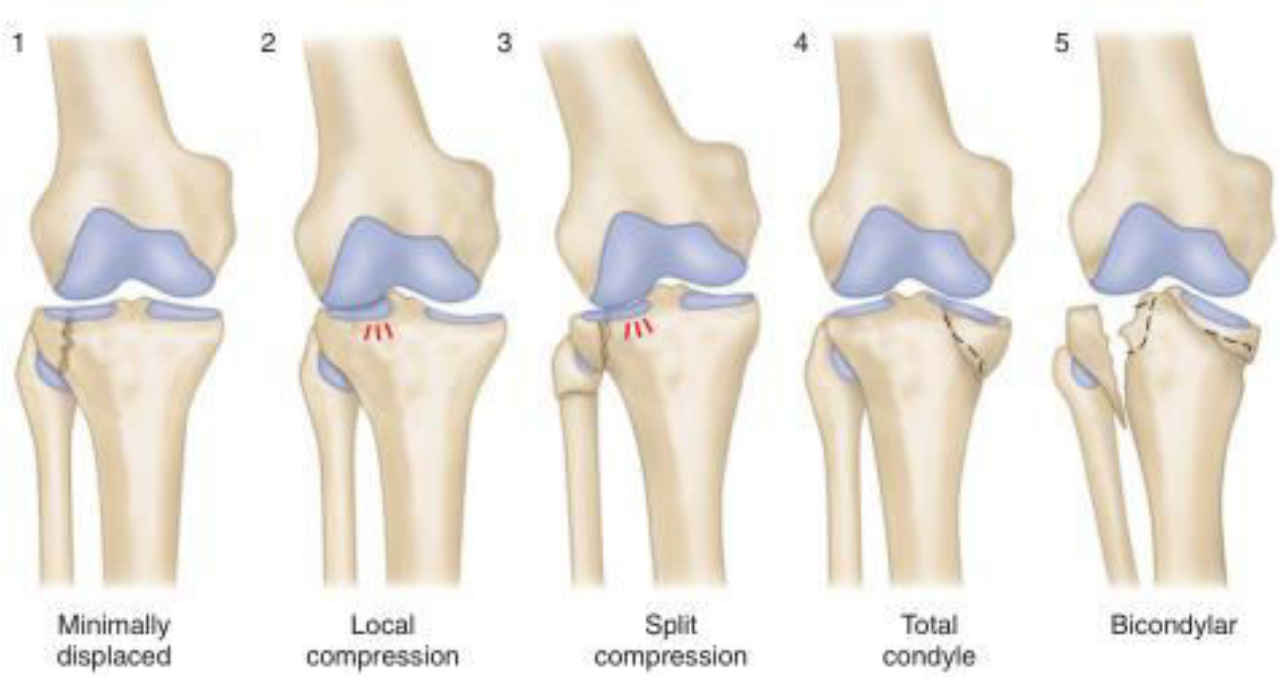


Fig 13: Hohl and moores classification- Fracture pattern.

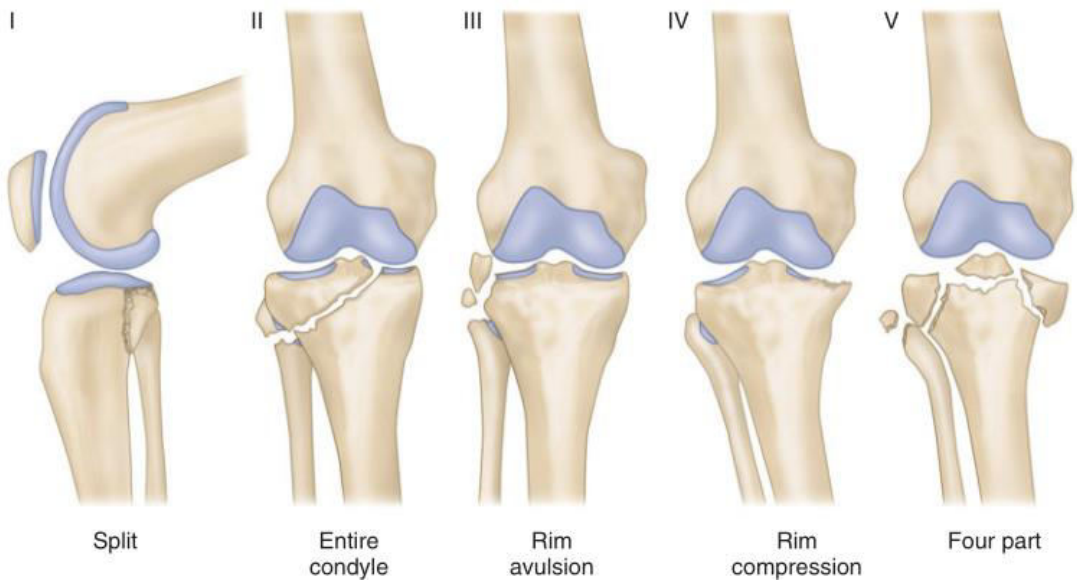


Fig 14: Hohl and moores classification- Dislocation pattern.

III AO CLASSIFICATION[46, 47]:

Type A:

These are extraarticular fractures of the proximal tibia. Technically, they are not considered as tibial plateau fractures because the articular surface is not involved.

Type B:

These are partial articular fractures of proximal tibia. These are lateral side terms and the AO/OTA classification allows similar, although less common, medial side injuries to be classified.

41 B1—proximal tibia, partial articular, split

41 B2— proximal tibia, partial articular, depression

41 B3— proximal tibia, partial articular, split with depression

Type C:

These are complete articular fractures.

41 C1— proximal tibia, complete articular, articular simple, metaphysis simple

41 C2— proximal tibia, complete articular, articular simple, metaphysis multifragmentary

41 C3— proximal tibia, complete articular, articular multifragmentary.

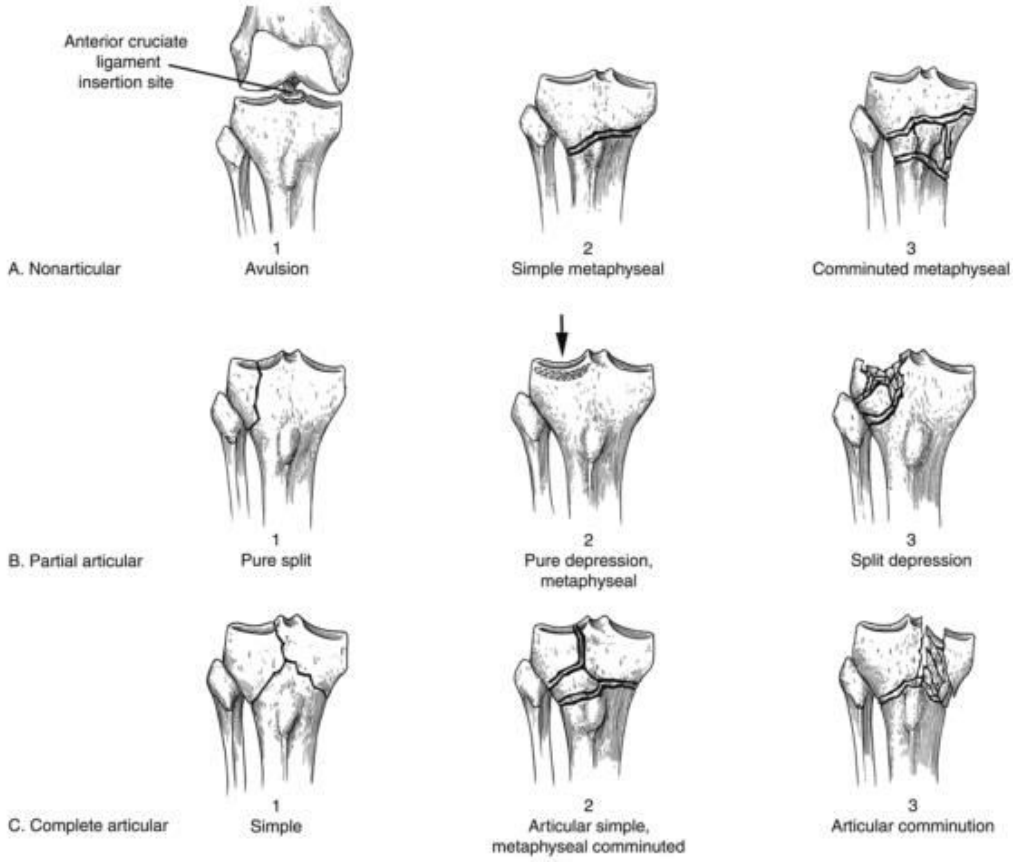


Fig 15: AO/OTA classification

IV THREE COLUMN CLASSIFICATION[22, 23]:

Other classification systems are mainly based on antero posterior view of knee radiograph. So, they cannot discriminate the major fracture line running in coronal plane like posteromedial fragments. Three coloumn concept of proximal tibia fractures is a novel concept increasing the

inter observer reliability regarding fracture classification also in proper pre operative planning also guides in choosing the proper approach for fixation in complex proximal tibial fractures and fractures with posterior communition.

Higgins et al in 1988 identified 59% posteromedial fragments in Bicondylar tibial plateau fractures. So, Luo et al in 2010 devised a three column concept classification based axial CT and three dimensional CT. In this classification, tibial plateau is divided into three columns namely medial column, lateral column and posterior column. Advantage of this system is it identifies the posteromedial fracture fragment which needs posteromedial approach and buttressing. Due to ease and simplicity of this classification, interobserver reliability is good

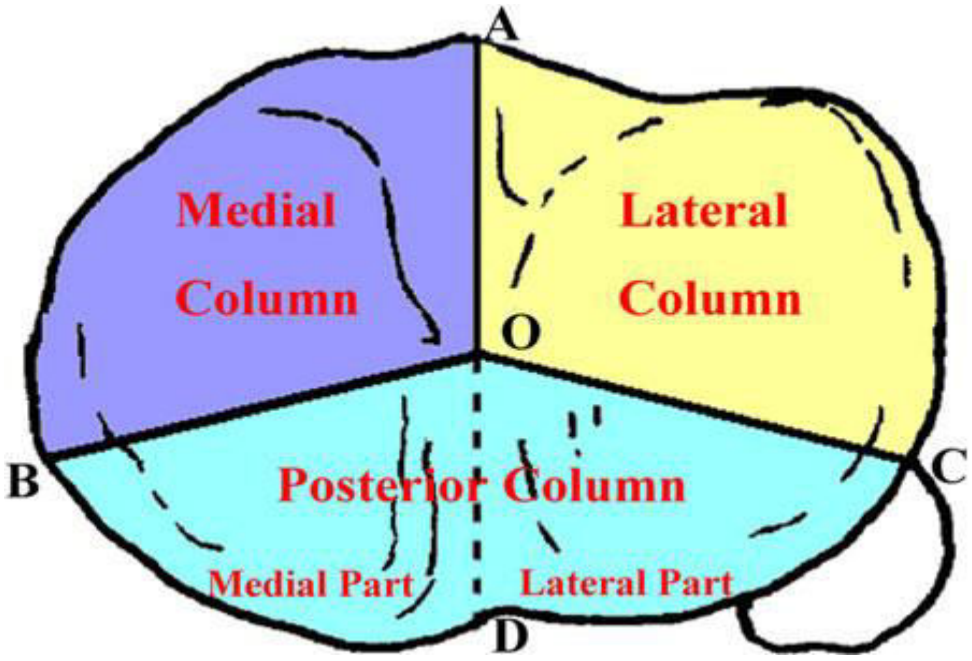


Fig 16: Three column classification.

- Zero column -schatzker type III

As per three column concept there should be a break in one cortex to classify it as a single column. So, only depression is considered as zero column

- One column - schatzker type I and II

  Articular depression in the posterior column with a break of the posterior wall is also defined as a one-column. Posterior column fracture -this type of fracture is not included in any type of the Schatzker classification. Consideration of posterior column is very vital because lack of fixation of posterior communition will lead to varus collapse in the post operative period.

- Two column - schatzker type IV

  Usually medial column associated with posteromedial fragment.

- Three column - schatzker type V and VI

  At least one independent articular fragment should be there in each column.

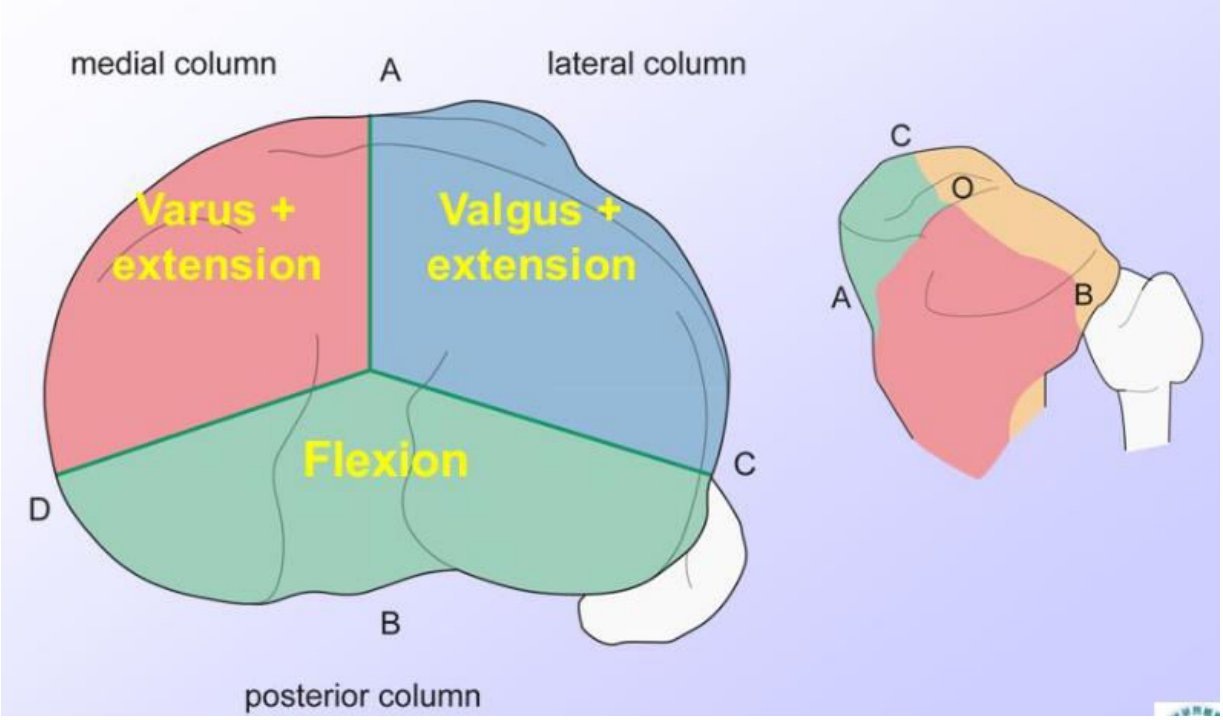


Fig 17: Morphology and injury mech

INVESTIGATIONS:

I PLAIN RADIOGRAPH:

- Anteroposterior & Lateral views usually show a proximal tibial fracture.
- In doubtful fracture 15° of caudal view to see articular surface.[48]
- films taken with traction and stress view radigraphs.

II CT SCAN:

- Axial cut of CT scan mainly used for three column classification.
- Mainly useful in classifying the fracture according to three column concept and to assess the articular depression.[22, 23, 49, 50]

III MRI:

- Differentiates the status of soft tissue structures like ligaments like meniscus and crucial/collateral ligaments.

- Not routinely done.

IV ANGIOGRAPHY:

- Useful in High velocity injuries with vascular compromise.

TREATMENT MODALITIES IN PROXIMAL TIBIA FRACTURES:

- **CONSERVATIVE MANGEMENT:**
  - Closed manual reduction of fracture and plaster of paris cast application.
  - Skeletal traction.
  - Functional cast brace application.[51,52]

Usually reserved for elderly, morbid patients who are not fit for anesthesia or who have higher risk for surgery because of their co morbidities.

If the reduction is not perfect, it will lead to osteoarthritis of the joint. The reduction should be perfectly maintained by rigid immobilization until bony union is complete in radiograph. Rigid immobilization of the fracture is also necessary to permit healing of associated ligamentous injury.

- **CLOSED REDUCTION WITH PERCUTANEOUS CANCELLOUS SCREW FIXATION:**

Displaced isolated medial and lateral column fractures with no articular surface depression are reducible by closed methods and percutaneuos cancellous screw fixation. Preoperative MRI or arthroscopy is

very much helpful in recognizing any meniscal injuries and any articular surface depression. C arm Image intensifier is must to accurately place the implants.

- **OPEN REDUCTION AND INTERNAL FIXATION:**[31, 32]

ORIF can be done using

- Cancellous screws
- Buttress plate and screws
- Locking plate and screws.

Augmentation can be done with cancellous bone grafts from iliac crest or synthetic bone graft substitute are commonly used as and when required.

Open reduction and internal fixation with locking compression plates and screws or external fixation is the treatment of choice for widely displaced incongruous, unstable or mal-aligned tibial plateau fractures. Preoperative planning is very important for achieving the necessary reduction. Pre operative planning is very much helpful to arrive at optimal fixation of the fracture and to clarify the need for supplemental bone grafts and to verify the availability of proper implants.

Locking plate acts as an internal external splint. Lateral locking plate provides stability to bicondylar fracture as an alternate method for dual plating to prevent soft tissue damage and to avoid tension.

Advantages of locking plate:

- Better distribution of forces along the axis of bone

- They can be inserted with minimal soft tissue stripping using minimally invasive percutaneous plate osteosynthesis(MIPPO)
- Substantially reducing failure of fixation in osteoporotic bones
- Reducing the risk of a secondary loss of intraoperative reduction by locking with screws to the plate.
- Unicortical fixation option
- Better preservation of blood supply to the bone as a locked plating does not rely on plate bone compression.
- Provide stable fixation by creating a fixed angle construct and angular stability
- Early mobilisation.[36, 37]

The main aim of open reduction is to attain perfect anatomical reduction of the articular surface and rigid fixation. All researchers agree that depressed articular fracture fragments will not change by manipulation or traction alone. An important factor which affects long term prognosis is the ability to maintain the normal anatomical alignment of the femoral condyle over the tibial plateau.

Main indications for fixing the tibial plateau fractures are

- Articular depression with displacement
- An open fracture
- Acute vascular injury
- Associated compartment syndrome
- Irreducible fractures

Fractures which are not reducible by closed methods are reduced by exposing the fracture using approach depending upon the type of fracture and visualizing the reduction physically by an inframeniscal arthrotomy. Depressed articular fragments are elevated through a cortical window or by retracting the split condyle fragment and the residual defect filled with autogenous bone grafts taken from iliac crest, bones from bone bank or synthetic bone graft substitutes and the fragments are fixed with cancellous screws or a buttress plate.

Medial column fractures are usually unstable which requires open reduction and internal fixation with medial buttress plate if required. Complex tibial condyle fractures that include bi column or tri column fractures are usually treated by open reduction and internal plate fixation. If there is severe swelling and pain limb should be monitored for compartment syndrome. The amount of communition, displacement and the soft tissue trauma should be evaluated preoperatively to avoid late complications.

Dual plate stabilization of severely comminuted bicondylar tibial plateau fracture involving two or more column, through separate surgical approach results in better outcome.

In case of open reduction and internal fixation, visualising the fracture fragments need periosteal stripping for proper reduction and fixing it. In such cases chances of non-union and the need for bone grafting are of great concern. The invention of locking compression plate helps in using minimally invasive approaches for unilateral plating. Minimally invasive technique reduces the soft tissue damage and reduces infection compared to ORIF.

- **RECONSTRUCTION OF ARTICULAR SURFACE USING EXTERNAL FIXATOR:[4-7]**

Two types of external fixator used

- Tubular type.
- Hybrid type.

For two column or three column bi condylar fractures external fixation using half pin fixator or ring fixator can be used as a definitive treatment of choice. External fixator placed below the knee can maintain congruity of the articular surface, alignment and early knee mobilisation.

The advantage of this external fixator is its minimal invasiveness thus reducing the soft tissue and wound complications. The half pin uniplanar fixators have advantage in open plateau fractures for temporary management until definitive fixation is done.

Associated meniscal and ligamentous injuries are treated either conservatively or by secondary repair depending on the severity of the injury through arthroscopy or open techniques.

The complications usually occur by the nature of fracture and also due to the modes of treatment. Many of the complications are easily preventable. Preventive care starts when the patient presented to the hospital with careful clinical examination of the injured limb. Important consideration should be given to identify the nerve and vascular injures that may accompany with the upper tibial fractures, prompt care and treatment of these injuries is of paramount importance than the fracture treatment and often prevent deadly complications.

- **EARLY COMPLICATIONS:**

- Hemartrosis
- Wound infection /Dehiscence - Superficial or Deep
- Sepsis
- Compartment syndrome
- Knee stiffness
- Nerve Injury (Common peroneal N)
- Vascular Injury (Anterior tibial A)
- Limb length discrepancy
- Deep vein thrombosis

- **LATE COMPLICATIONS:**
    - Wound Infection
    - Knee stiffness
    - Malunion
    - Knee instability – varus/valgus/anterior/posterior
    - Extensor lag
    - Angular deformities
    - Persisting pain/swelling
    - Delayed union
    - Non-union

SURGICAL APPROACHES:

Two approaches commonly used in ORIF of tibial plateau fractures, namely

- Anterolateral approach

- Posteromedial approach

Both are respectively used for lateral and medial column fractures.

Anterolateral approach:

This is the commonly used approach to surgically treat lateral column fractures. Split depression or pure depression type of the lateral tibial condyle fractures was reduced by this approach. Proximally the incision is started from the Gerdy's tubercle and is extended distally over the anterior compartment along the tibial shin. Usually inverted L-shaped incision made over the tibial shin provides adequate access to the anterolateral surface of the tibia. While dissecting over the posterolateral border of the tibia maximum care to be taken to avoid the anterior tibial artery injury which usually passes through the interosseous space.

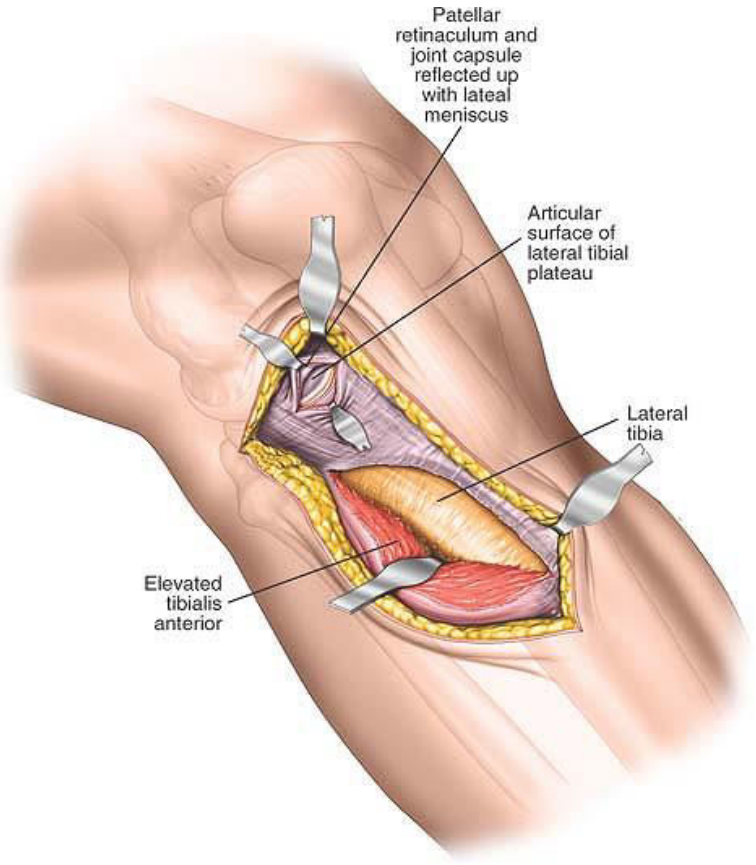


Fig 18: Anterolateral approach.

Posteromedial approach:

The posteromedial approach is used for open reduction and fixation of the fracture on the posterior column and medial column of the proximal tibia mainly for the posteromedial fragment. This approach has a advantage with regard to soft tissue injury that it has got relatively adequate soft tissue cover and it is far away from the anterolateral approach allowing these two approaches to be easily combined when necessary to reduce soft tissue complications. Posteromedial plating is helpful to buttress the posteromedial fragment. An anti-glide plate is a form of buttress plate which is placed over the fracture to prevent it from gliding due to the forces acting on it. Patient usually kept in supine position so that it allows access to the front of the knee for a second anterolateral approach. The leg is externally rotated to access posteromedial region and internally rotated to access anterolateral region.

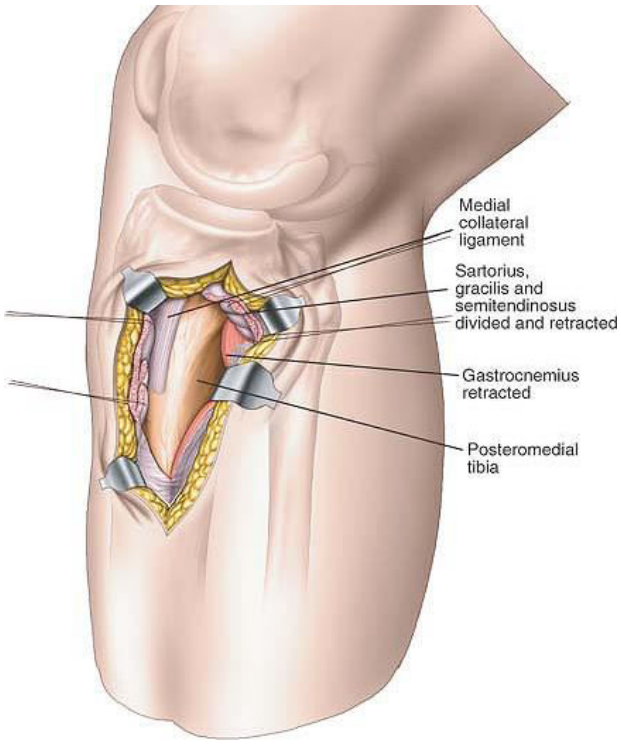


Fig 19: Posteromedial approach.

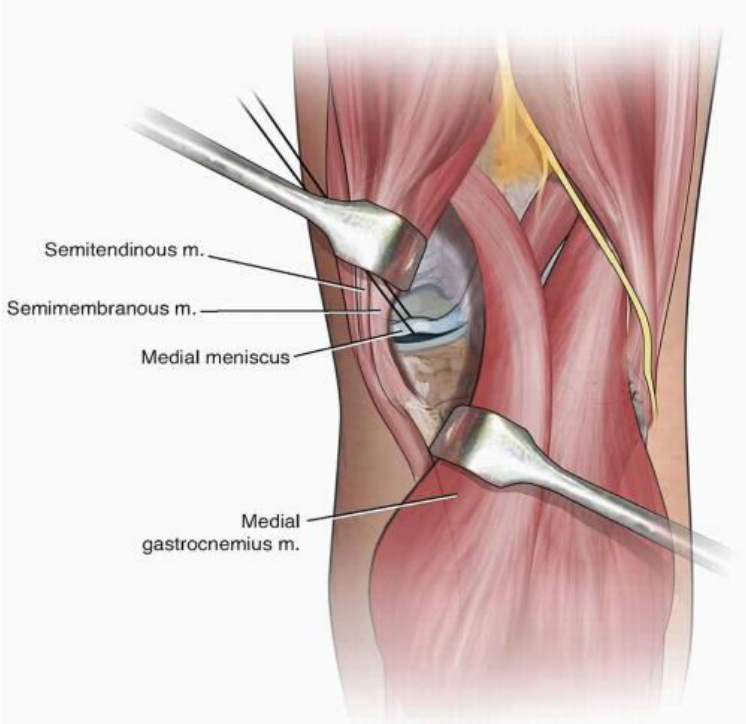


Fig 20: Posteromedial approach in prone position.

Alternatively, prone position of the patient can be used to access posteromedial region but in this position we cannot access the anterolateral region. Prone position also facilitates posterior column fracture reduction by spontaneous knee extension. Otherwise we can make the patient floppy lateral position a position which is midway between lateral and prone position, internal rotation allows posteromedial approach and external rotation of leg allows anterolateral approach.

Care must be taken to avoid saphenous nerve and vein during subcutaneous dissection. The deep plane of this approach is between the posterior aspect of the pes anserine tendons and the medial head of gastronemius. A retractor which is used to protect the popliteal fossa structures should be placed underneath the medial head of gastronemius to. Splitting the medial head of gastronemius further increases the exposure in the posteromedial

approach. Popliteus muscle origin also sometimes erased and retracted laterally which increases the visualization of the fracture.

Anteromedial approach:

The anteromedial aspect of tibial plateau is easily accessed through similar to an approach used for total knee arthroplasty. But, it is highly unusual for fracture patterns to involve the anteromedial tibia in alone.Medial column fracture patterns often involve the posteromedial plateau, which requires a posteromedial approach. Occasionally through the same skin incision, a separate anteromedial interval can be made in front of or between the pes anserine tendons to reduce and fix through posteromedial approach.

Posterlateral approach:

If we encounter posterolateral comminution which is difficult to stabilize from an anterolateral approach, this approach can be used. If the posterior plateau is comminuted on the far lateral side, it cannot be stabilized through the posteromedial approach. So, a posterolateral approach which has a plane between the biceps femoris and the lateral head of gastronemius is needed to access the posterolateral column. Mobilization of the peroneal nerve is a must to increase access and to protect the nerve from injury.

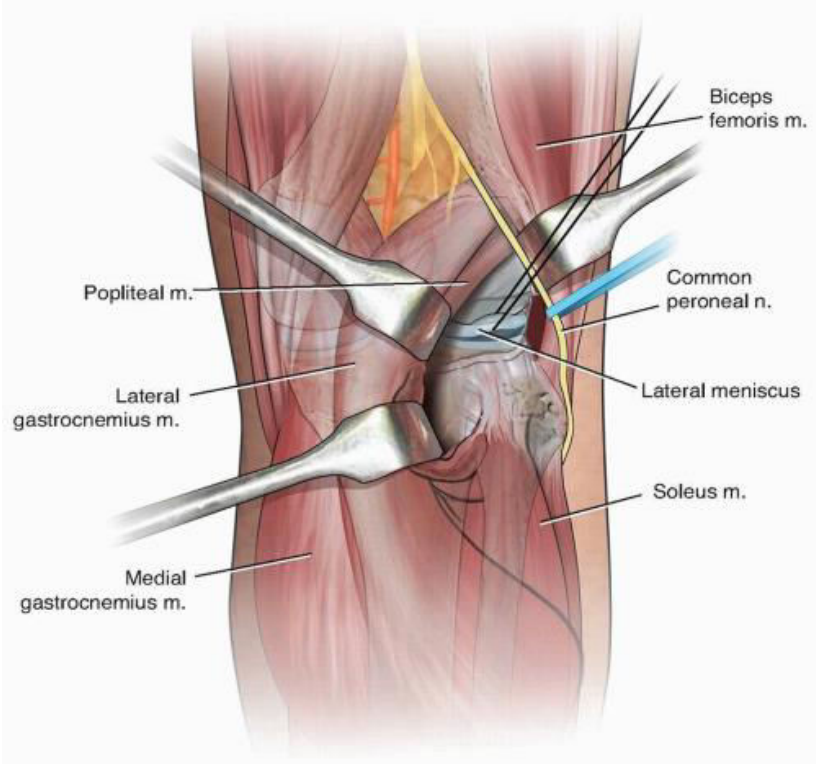


Fig 21: Posterolateral approach.

Extensile anterior approach:

Extensile approaches have been used for complex bi column tibial plateau fractures earlier. Exposure is similar to that of total knee replacement. They have the advantage that they provide simultaneous access for medial and lateral column of the tibial plateau.

However, these exposures, along with dual plating, lead to excessive soft tissue and periosteal stripping and devascularization of damaged fragments, and eventually they resulted in infection and/or wound breakdown, disastrous results followed. So research data advises combined posteromedial and anterolateral approaches are better than extensile anterior approach in treating Bicondylar fractures with regard to soft tissue complications.

Methodology

MATERIALS AND METHODS

This is a study of functional outcome in proximal tibia fractures treated using three column concept conducted in the department of orthopedics at Government Stanley Medical College, Chennai from July 2016 to July 2018 after getting clearance from hospital ethical committee.

During above mentioned period 30 patients were treated for tibial plateau fractures using three column concept in which all patients were treated by internal fixation.

All the required data for the study was collected from the patients after getting their appropriate consent during their stay in the hospital, during follow up at regular intervals and from the medical records.

Inclusion Criteria

- Patients above 15 years to 60 years of either sex.
- Closed tibial plateau fractures.
- Diagnosis of fractures with three column concept classification.

Exclusion Criteria

- Patients age below 15 years.
- Open tibial plateau fractures.
- Patients medically unfit for surgery.
- Pathological fractures other than osteoporosis.
- Neurovascular injuries.

Methodology:

This was a prospective study. All participated patients were chosen on the basis of history, clinical examination and radiography.

- The three column concept classification was used to classify these fractures. The patients were followed up for an average period of 6 months.
- Fractures will be considered unstable if depression>4 mm or displacement>10°
- All cases were treated with ORIF and approach chosen according to the column involved.
- Fixation done by using
    - 'L' buttress plate
    - 'T' buttress plate
    - Proximal tibial locking compression plate
    - Distal radius 'T' plate
    - Distal radius locking compression plate
    - 1/3rd tubular plate
    - 6.5 mm cancellous screws
    - 4.5 mm cortical screws
    - 3.5 mm cortical screws
    - 4 mm cancellous screws
- Follow up and functional assessment was performed using modified Rasmussen's clinical criteria.

Management:

Patients were first seen in the emergency trauma ward. The history was taken followed by clinical examination of the patient. If there is any associated system injuries, concerned specialists undertook appropriate management. Intensive monitoring and care was given to those patients who presented with shock and immediate resuscitative measures were undertaken.

Once the patient's general condition was stable, relevant X-rays and CT scan for classification were taken.

The treatment method was decided after classifying the type of fracture, the displacement and the amount of depression of the tibial plateau. The patients were taken for surgery as early as possible time depending on their co morbidities and skin condition. All surgeries were done under image intensifier control. Fractures were fixed by open reduction and internal fixation. In our study we used floating position also known as floppy lateral position[22] for fractures involving bi column that is lateral column and posteromedial column, a position which is midway between lateral and prone position, internal rotation allows posteromedial approach and external rotation of leg allows anterolateral approach. For fractures of other single column we used standard approaches.

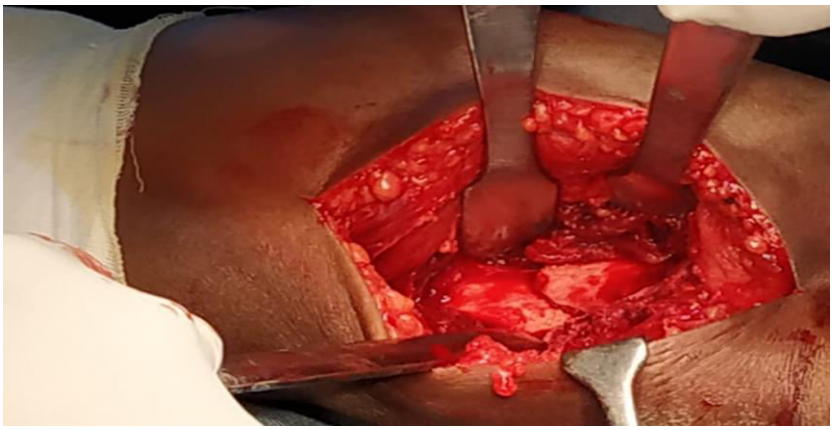


Fig 20, 21, 22: Intra operative pictures of posteromedial approach in floating position.

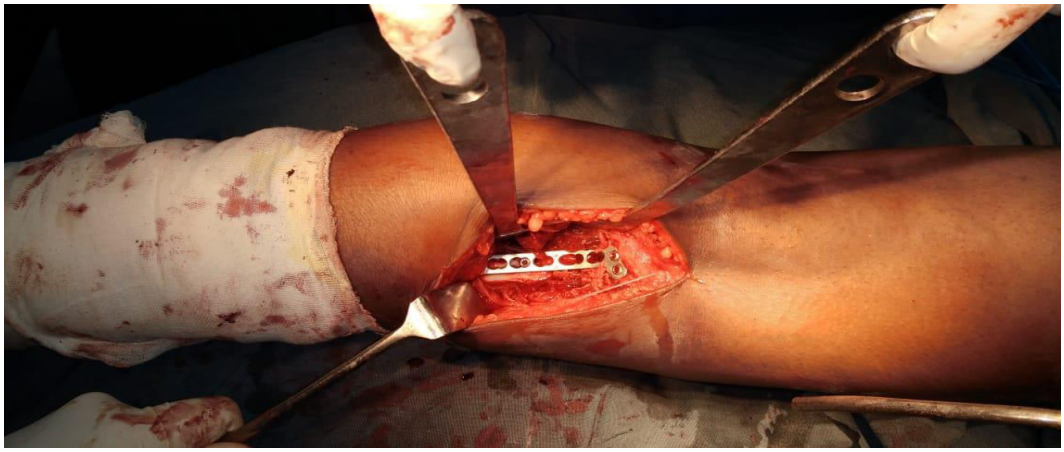


Fig 23, 24: Intra op reduction clinical and C arm picture

Bone grafts were used in depressed and comminuted fractures. The source of bone graft was ipsilateral iliac crest or synthetic bone graft substitute

Postoperatively patients treated with above knee POP slab for immobilization or compression bandage for 2 weeks. The sutures were removed on the thirteenth postoperative day. 5 days of intravenous antibiotics and 8 days of oral antibiotics were given. The patients were encouraged to do static quadriceps exercises for initial 3 weeks followed by passive knee range of motion and non-weight bearing crutch walking using unaffected limb up to 6

weeks after 6 weeks knee mobilization and assisted weight bearing crutch walking. An immediate postoperative X-ray was also done later on follow up X-ray repeated at 6 weeks, 3 months and 6 months.

Follow up:

The first follow up was done at 3 weeks, during that time the surgical scar was examined for any discharge or tenderness and range of movements noted. The second follow up done at 6 weeks during which a repeat X-ray was taken to look for fracture union or loss of reduction.

The third follow up was done at 3 months post operatively during which one more repeat X-ray was done and a clinical evaluation of union also done. Patients were allowed for partial weight bearing and gradually progressed to full weight bearing based on the clinical and radiological signs of union. The patients were then asked to come for follow up at 6 months, during which time the functional evaluation was done using the modified Rasmussen clinical criteria.

Modified Rasmussen Criteria for Clinical Assessment[54, 55]

Pain	
None	6
Occasional	5
Stabbing pain in certain position	3
Constant pain after activity	1
Significant rest pain	-3
Walking Capacity	
Normal walking capacity for age	6
Walking outdoor more than one hour	5
Walking outdoor 15 mins – 1 hr	3
Walking ourdoor < 15 mins	1
Walking indoor only	0
Wheel chair or bed ridden	-3
Knee Extension	
Normal	4
Lack of extension $<10^0$	2
Lack of extension $>10^0$	0
Lack of extension $>20^0$	-2
Total Range of Motion	
Full	6

Atleast 120^0	5
Atleast 90^0	3
Atleast 60^0	1
$<60^0$	-3
Stability	
Normal stability in Extension and 20^0 Flexion	6
Abnormal instability in 20^0 Flexion	4
Instability in Extension $<10^0$	2
Instability in Extension $>10^0$	0
Power of quadriceps	
Grade 5	2
Grade 3-4	1
Grade < 3	-2
Maximum Score	30
Excellent	28-30
Good	24-27
Fair	20-23
Poor	<20

Results

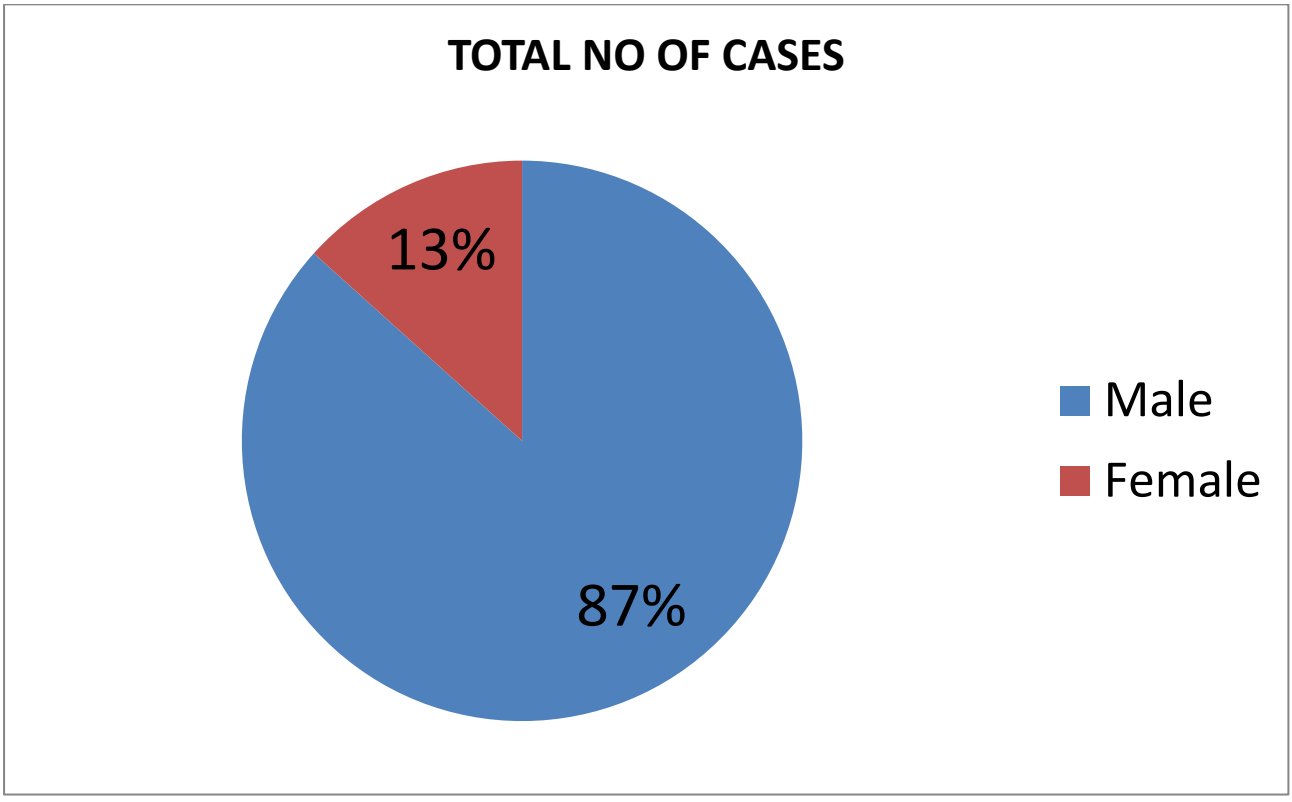
RESULTS

FREQUENCY OF SEX INCIDENCE:

In our study thirty patients were assessed between July 2016 to July 2018 of which twenty six cases were male and four of them were female.

Mean age of male 39.8 years and mean age for females is 32.3 years.

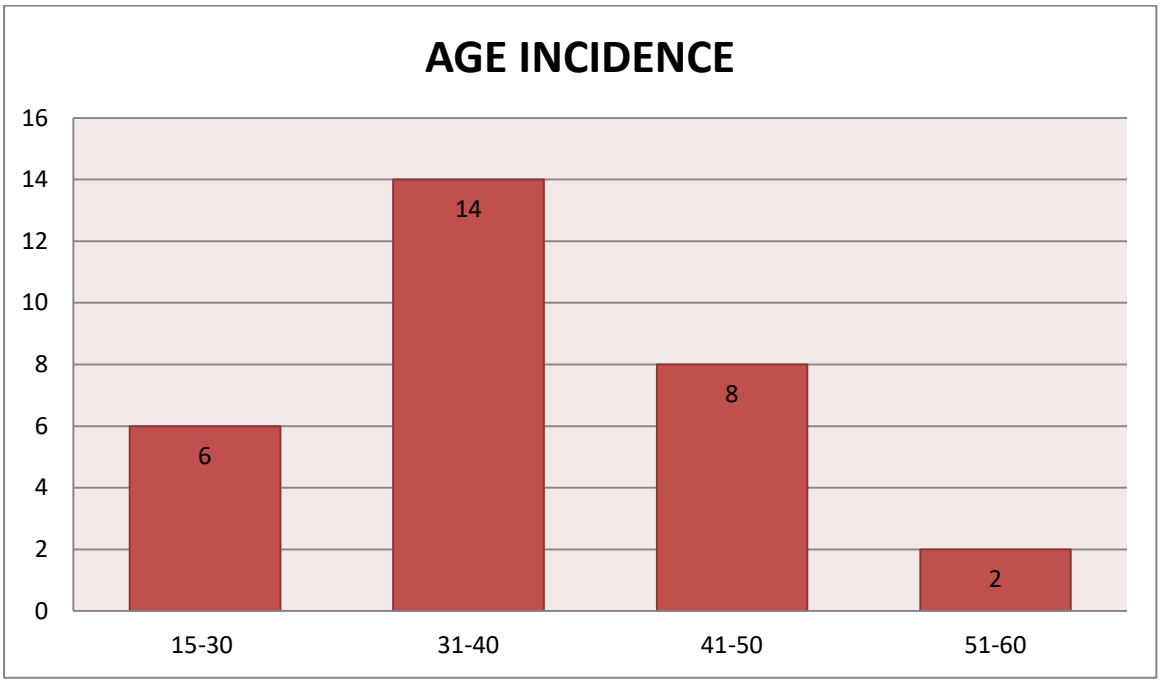
SEX	NO OF CASES	PERCENTAGE
Male	26	87
Female	4	13
Total	30	100



AGE INCIDENCE:

In our study most patients belongs to 4th and 5th decade which has the higher association of 74 percent.

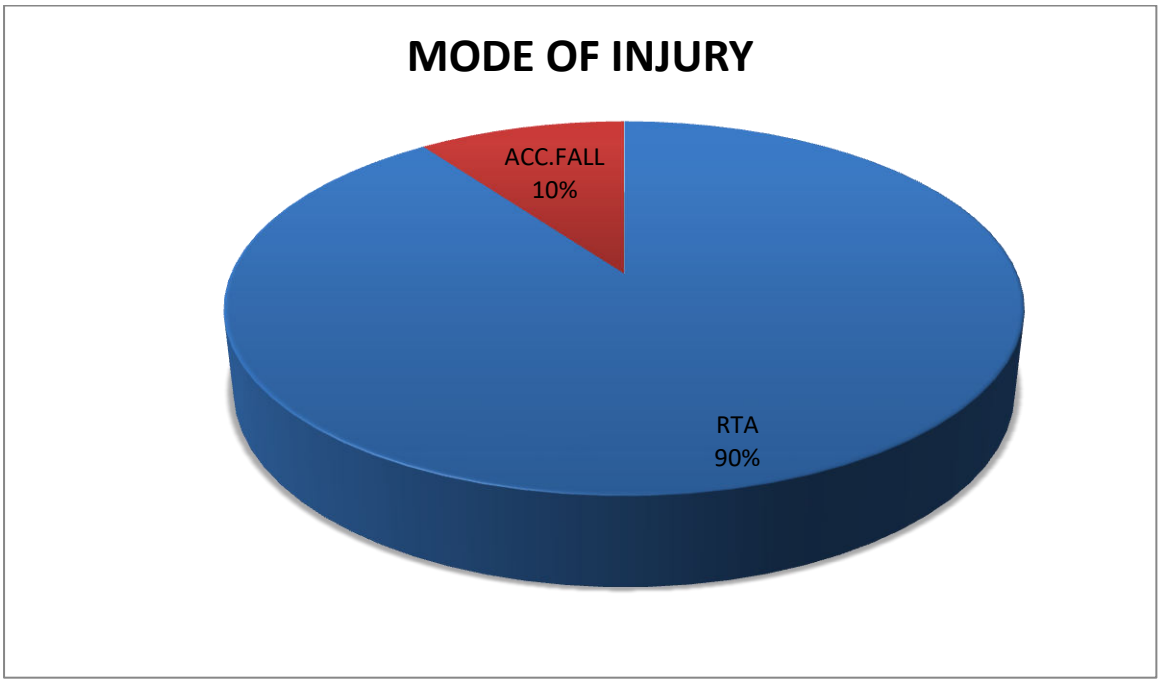
AGE	NO OF CASES	PERCENTAGE
15-30	6	20%
31-40	14	47%
41-50	8	27%
51-60	2	6%
TOTAL	30	100



MODE OF INJURY:

In our study road traffic injury is the higher associated mode of injury for tibial plateau fractures which is around 90 percentage.

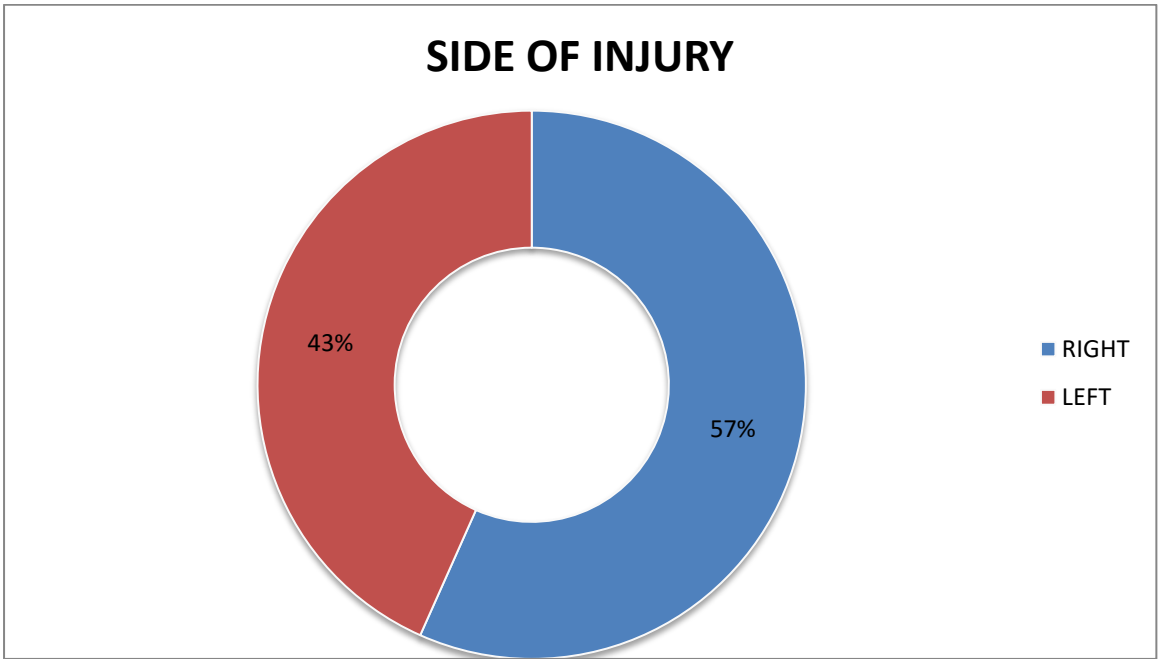
MODE	NO OF CASES	PERCENTAGE
Road traffic accident	27	90%
Accidental fall from height	3	10%
TOTAL	30	100%



SIDE OF INJURY:

In our study 57% of the patients sustained injury to the right side and 43% to the left side. In our study, there is right sided predominance, when compared to the left side.

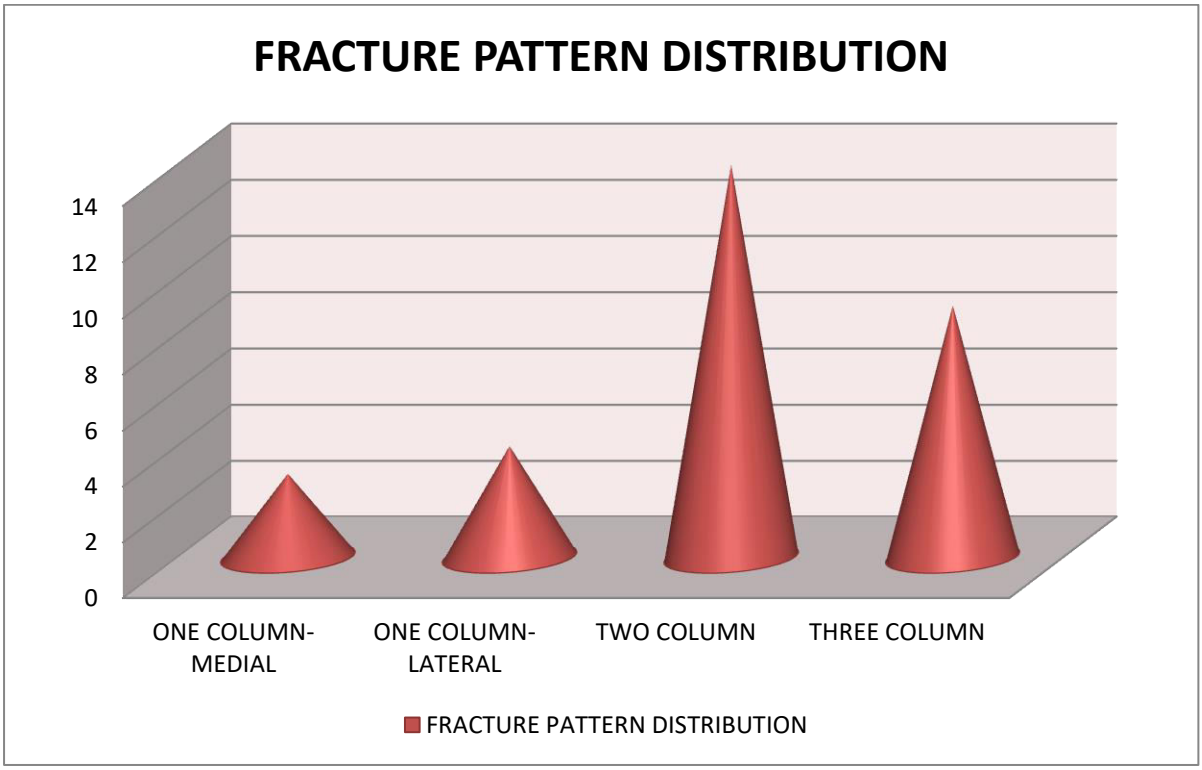
SIDE OF INJURY	NO OF CASES	PERCENTAGE
RIGHT	17	57%
LEFT	13	43%
TOTAL	30	100%



TYPES OF FRACTURE:
THREE COLUMN CONCEPT CLASSIFICATION:

In our study proximal tibia fractures involving medial column constitute 10% and involving lateral column constitute 13% fractures involving two columns constitute 47% and fractures involving all three columns constitute 30% of total study population.

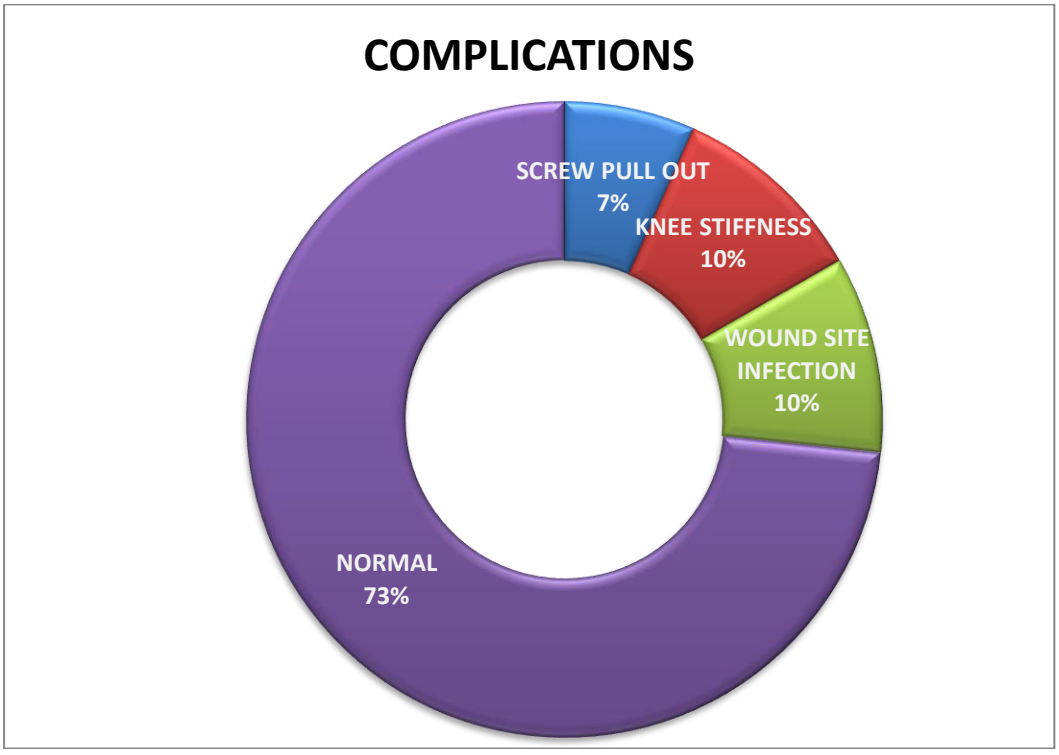
TYPE OF FRACTURE	FREQUENCY	PERCENTAGE
ONE COLUMN-MEDIAL	3	10%
ONE COLUMN- LATERAL	4	13%
TWO COLUMN	14	47%
THREE COLUMN	9	30%



COMPLICATIONS:

Majority of the fractures treated in our study are united without much complications except we encountered screw pull out of the buttressing screws fixed in posterior column in two patients once we started mobilizing the knee by 6th week post operatively which necessitated screw removal of the pulled out screws. We also had knee stiffness in three patients who had knee movements in the range of 30° to 85° flexion with associated pain with no extension and we had wound site infection in three cases which were managed accordingly of which two patients had deep infection which necessitated implant exit.

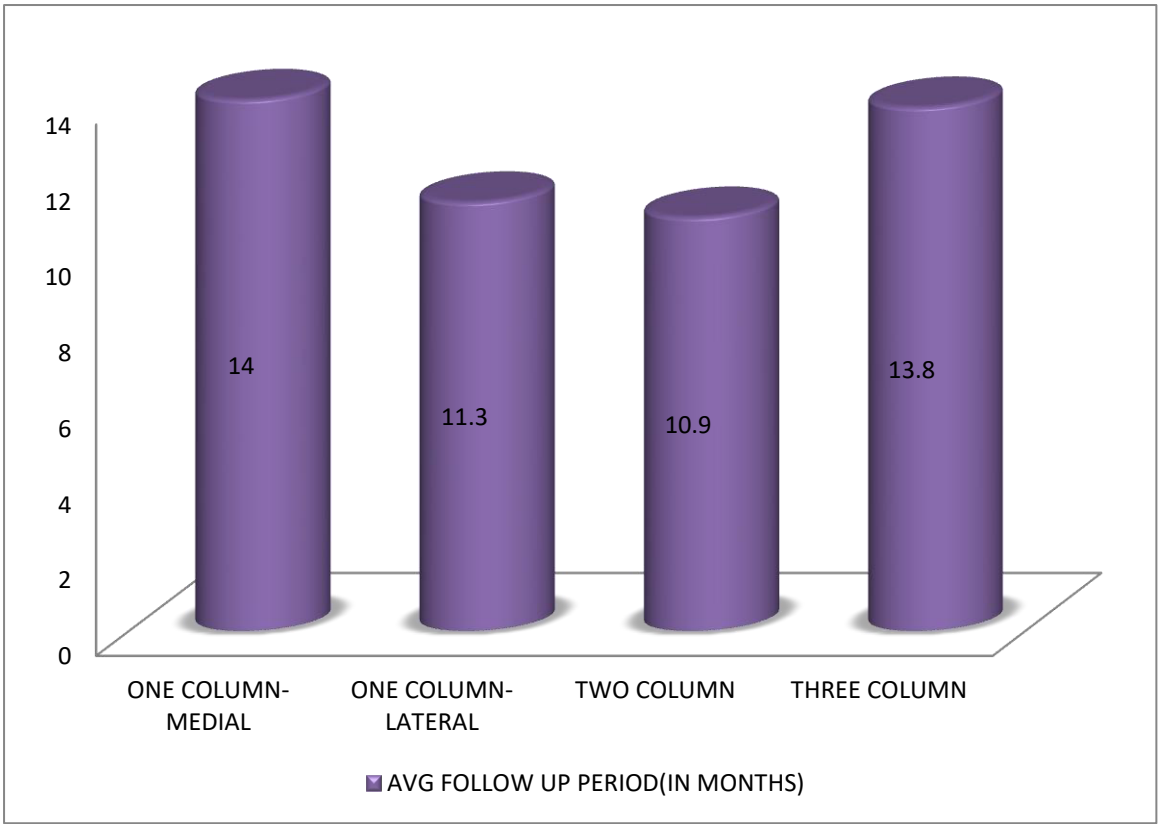
COMPLICATION	NO OF CASES	PERCENTAGE
SCREW PULL OUT	2	7%
KNEE STIFFNESS	3	10%
WOUND SITE INFECTION	3	10%
NO COMPLICATION	22	73%



MEAN FOLLOW UP:

Mean follow up period of our study is 12.5 months. In that mean follow up period of respective column fractures given in the table below.

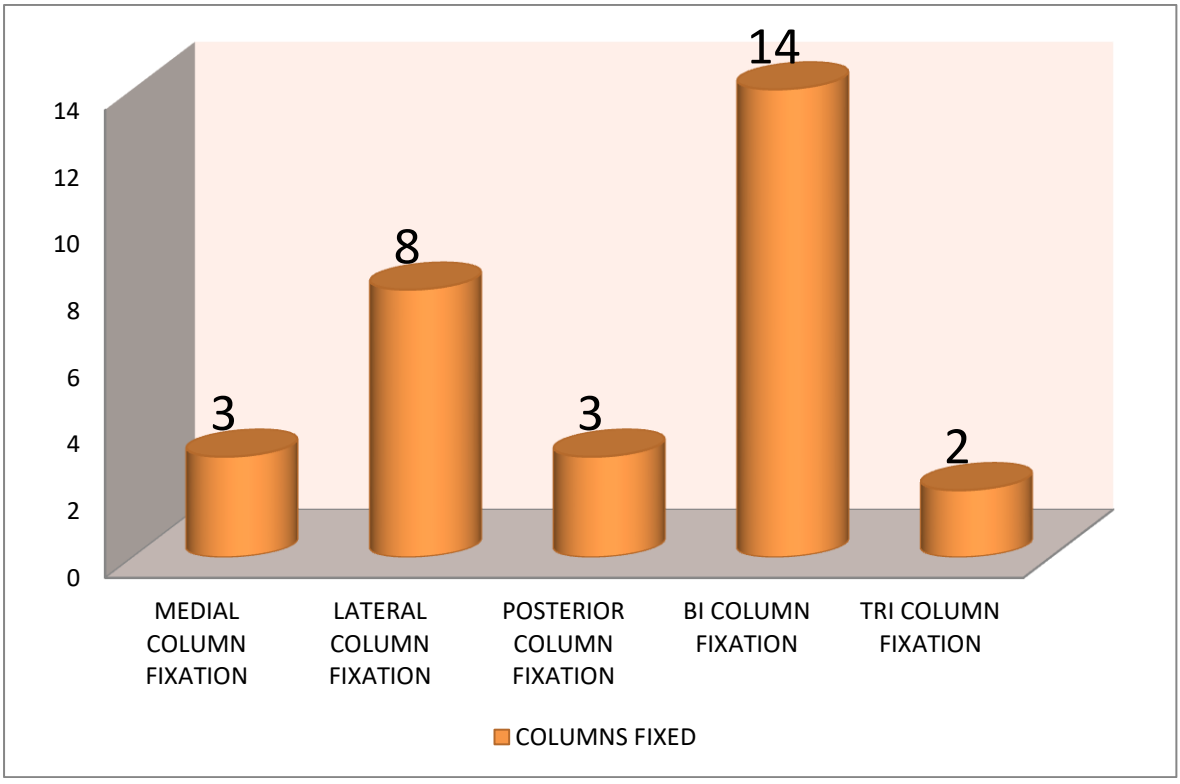
S.No	TYPE OF FRACTURE	AVG. FOLLOW UP(IN MONTHS)
1)	ONE COLUMN- MEDIAL	14(15-17)
2)	ONE COLUMN- LATERAL	11.3(9-12)
3)	TWO COLUMN	10.9(6-22)
4)	THREE COLUMN	13.8(6-20)



COLUMNS FIXED:

In our study we fixed only medial column for 3 patients, lateral column only for 8 patients, posterior column only for 3 patients, two column fixation done for 14 patients and three column fixation for 2 patients. The number of columns to be fixed was decided pre operatively after assessing the axial CT scan and radiograph then intra operative reduction assessed through C arm image intensifier to confirm our decision.

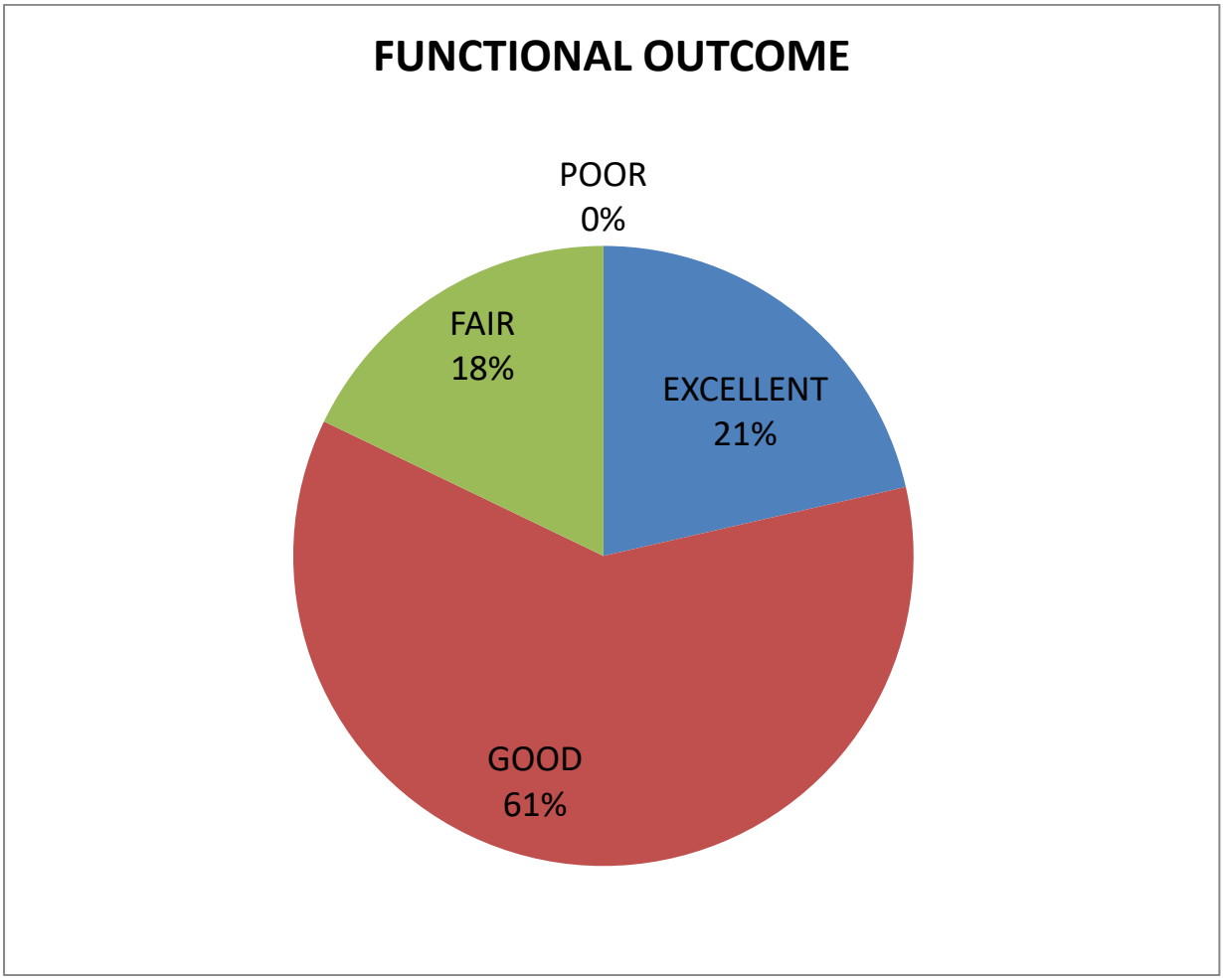
COLUMNS FIXED	NO OF CASES	PERCENTAGE
MEDIAL COLUMN FIXATION	3	10%
LATERAL COLUMN FIXATION	8	27%
POSTERIOR COLUMN FIXATION	3	10%
BI COLUMN FIXATION	14	46%
TRI COLUMN FIXATION	2	7%



CLINICAL RESULTS:

In our study we found that 20% had excellent score according to Rasmussen's clinical score, 64% had good score and 16% had fair score. No patient had a poor score even after surgical site infection in 3 cases. In other cases also the score is good which shows importance of three column concept on management of periarticular proximal tibial fractures.

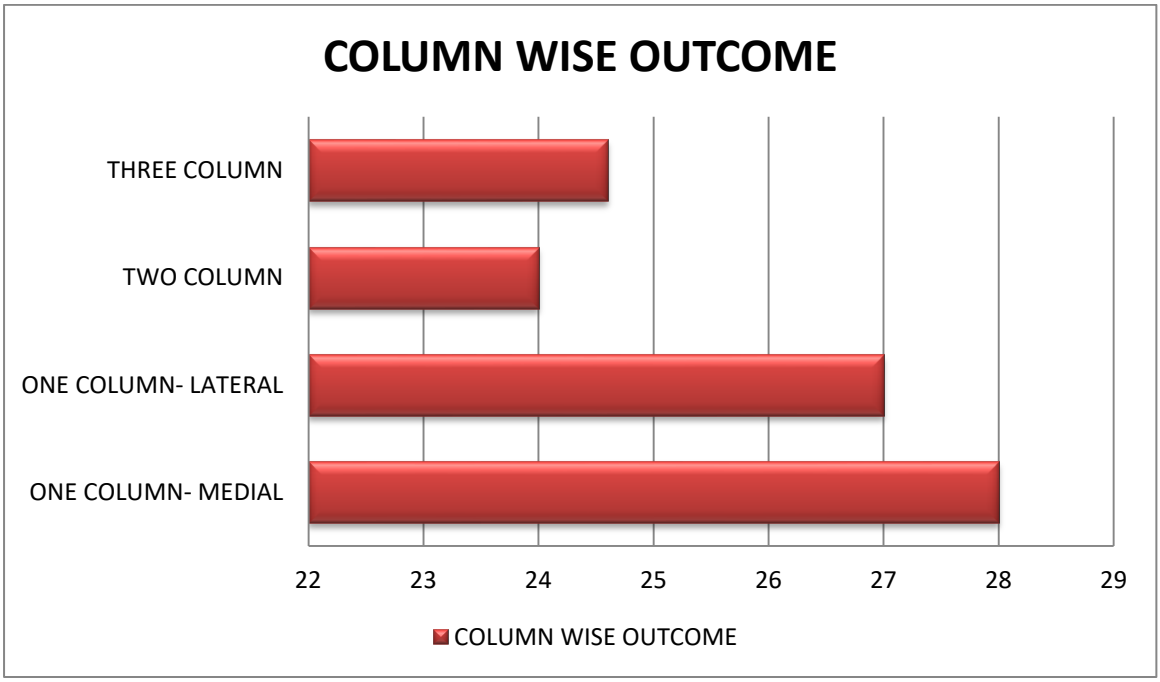
SCORE	NO OF CASES	PERCENTAGE
EXCELLENT	6	20%
GOOD	19	64%
FAIR	5	16%
POOR	0	0%



OUTCOME OF INVIDUAL FRACTURE PATTERNS:

COLUMN INVOLVED	MEAN RASMUSSEN SCORE	CATEGORY
ONE COLUMN- MEDIAL	28	EXCELLENT
ONE COLUMN- LATERAL	27	EXCELLENT
TWO COLUMN	24	GOOD
THREE COLUMN	25	GOOD

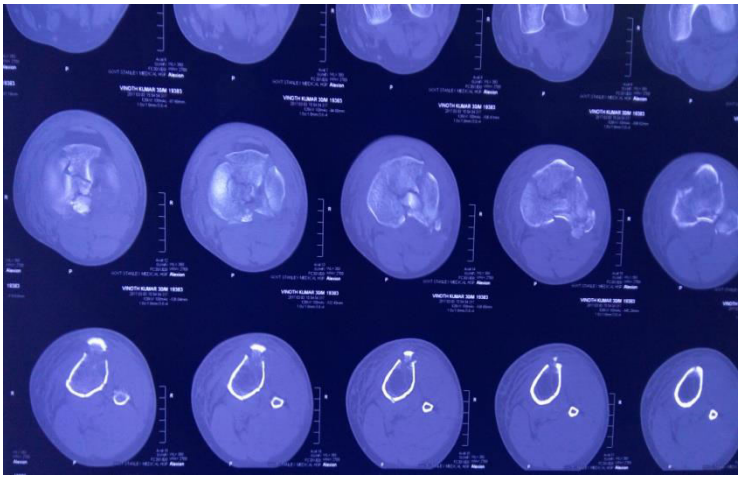
In our study we had excellent and near excellent outcome in single column fractures but as fracture becomes complex, the outcome also reduced to become good in two and three column fractures.



CASE ILLUSTRATION

CASE 1:

Pre op



Ct scan-three column involvement

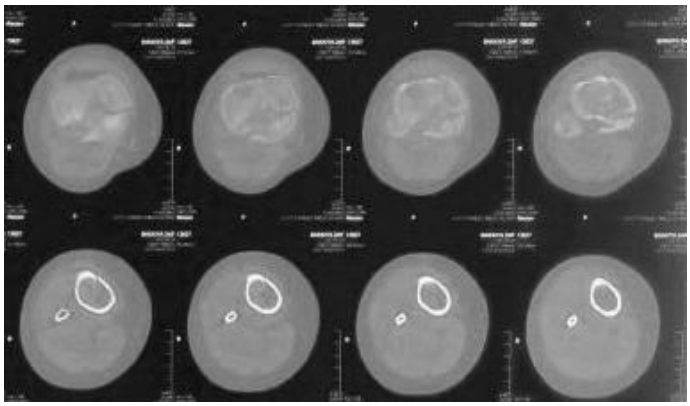
Immediate post op

6 months post op

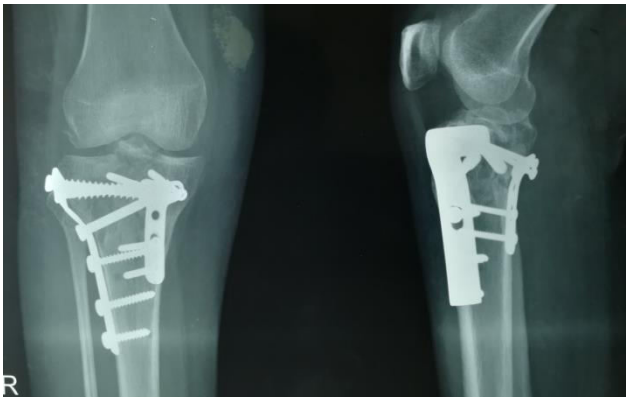
Functional outcome- knee ROM

CASE 2:

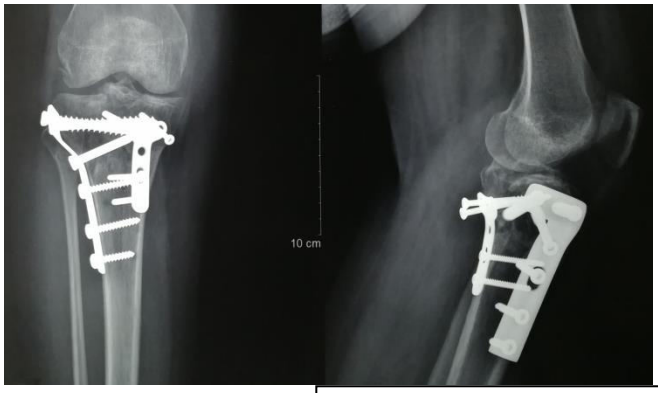
Pre op



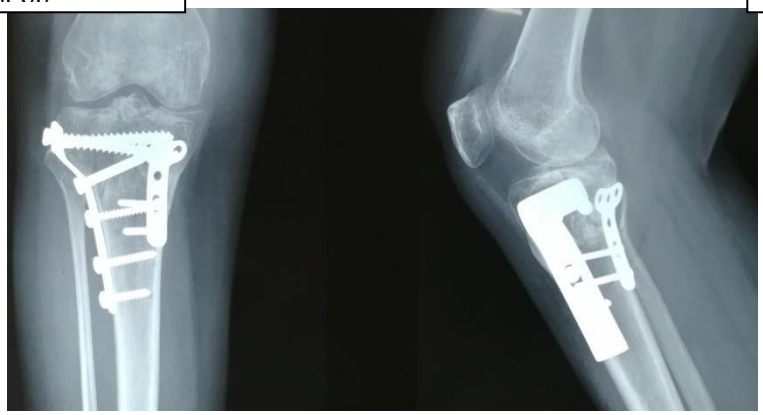
Ct scan- 3 column involvement



Immediate post op



2nd month -screw pullout

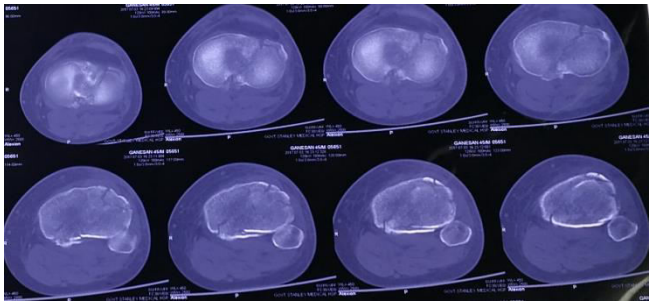


6 months follow up

Post op functional outcome knee ROM

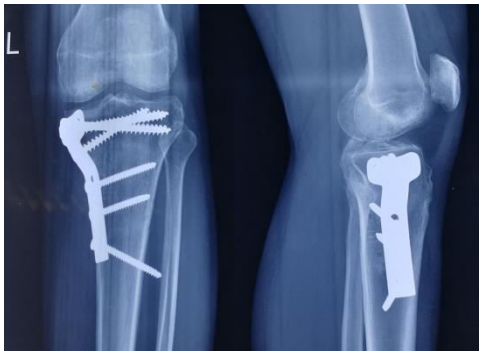
CASE 3:

Pre op



Ct scan- single column (medial)

Immediate post op



6 month post op

Post op functional outcome knee ROM

Discussion

DISCUSSION:

Proximal tibia fractures which are one of the commonest intra articular fractures are occurring as a result of motor vehicle accident, accidental fall from height, violence etc. The management of proximal tibial fracture has always been a subject of discussion because of their complexity and variety. Any fracture in around the joint (especially weight bearing knee joint in the lower limb) is of paramount importance as adverse outcome would result in significant morbidity and quality of life may be affected negatively.

Tibial plateau fractures are more commonly seen in the active, earning younger age group due to their exposure to high velocity motor vehicle accidents. Closed treatment of these injuries has had very little success in reducing depressed or displaced fracture fragments; this initiated the need for open reduction and internal reduction in most displaced and unstable fractures. It is also extremely important to do a stable fragment fixation and ligament repair to regain the complete range of movements.

Open reduction and internal fixation has the advantage of direct visualization of fracture, complete reduction, and fixation, but there is higher risk of soft tissue complications, joint stiffness and deep compartment infection. The hybrid fixator system avoids these soft tissue complications, but risks are malunion, pin site infections and reduced patient compliance in maintaining the hybrid fixator.

The concept of preserving the blood supply to the bone and minimally invasive technique lead to the development of more biological fixation techniques. By using this technique, soft tissue complications are very much reduced and show higher rates of union.

Aim of our study assessing the functional outcome of proximal tibia fractures treated using three column concept classification instead of conventional classifications like Schatzker classification. The advantage of three column classification is it increases the inter observer reliability due to its simplicity and also it considers posterior fracture fragment which is often not considered in Schatzker classification. The posterior column fragment usually addressed by buttressing the fragment using posteromedial approach. If the posterior column is not considered for fixation it may lead to varus collapse in the post operative period and reduced range of movements of the knee.

The invention of locking compression plates has allowed the surgeons in using MIPPO technique for unilateral plating with improved care and management in handling the soft tissue. Laterally applied locking compression plates provide better stability in context of complex proximal 1/3rd tibia fracture associated with metaphyseal comminution and serves as an good alternative to medial plate or external fixator which are used for additional support of the medial column when a non-locking plate is used for bicondylar fractures. This

plate allows fixation through single incision to avoid wound dehiscence, prolonged immobilization and infection associated with extensile approaches.

There is no reliable universal scoring system to assess the functional outcome of these fractures. Past researchers used multiple scoring systems like Rasmussen, oxford knee score and knee society score. In our study, we have assessed the functional outcome of the patients using modified Rasmussen score which is a subjective score based on patient's experience.

Mechanism of injury was road traffic accident for majority of these patients. The fractures were classified using three column concept classification. In our study we assessed thirty patients from July 2016 to July 2018 of which twenty six cases were male and four of them were female. Mean age of male 39.8 years and mean age for females is 32.3 years.

In our study patients with medial column fractures were 3 and involving lateral column were 4. Fractures involving two columns which is most common were 14 and fractures involving all three columns were 9.

In our series majority of the patients were males (87%). The significance of tibial plateau fracture-related sex distribution was not available in literature to comment on them.

In our study, there was right sided predominance, compared to the left side with right side 53% and left side 47%. In this study we studied 30 cases of tibial plateau fractures all of them were treated by open reduction and internal fixation. The indications for open reduction and internal fixation were the same

standard indications used by the earlier authors as for the tibial plateau fractures.

We have not formulated any criteria as to particular method of fixation for particular column of fracture. So each case was individualized and treated accordingly as needed with good preoperative workup. Apart from the one column fractures which were treated with unilateral plating, some two column (4 cases) and three column(3 cases) fractures also treated with unilateral plating after assessing the radiograph of the knee, axial CT scan and intra operative reduction with image intensifier. Likewise choice of the implant was decided on the fracture pattern, bone quality and intra operative reduction.

The period of immobilization was standardized to 3 weeks for all column of fractures

The major problems faced by us during the course of this study were knee stiffness and infection and screw pull out. The infection may be attributed to nosocomial infection.

In spite of all the complex fracture patterns and soft tissue injuries injuries and complications with proximal tibial fractures, we can able to achieve excellent results in 20% of the study population and good results in 64% of the study population (overall 84% satisfactory results) with described standard fixation methods. In addition we have 16% fair and 0% poor results. The above said results are comparable to the literature and on par with other documented standard studies. The results show the superiority of the three column concept classification over other conventional classifications especially Schatzker

classification in pre operative planning and intra operative execution. It is very simplistic to understand which reduces inter observer variability in assessment is another icing on the cake.

Schatzker classification based

Rambold et al in 1992	93% acceptable
Seppo E. et al in 1993[55]	86% satisfactory
Joseph Schatzkar et al in 1986[30]	86% satisfactory

Ao classification based

Chung wug oh et al[64]	84% satisfactory

Three column concept based

Luo et al in 2010[22]	86% satisfactory
Our study	**84% satisfactory**

Dual plating for two columns or three column fixation gives better biomechanical strength and rigid construct than unilateral plating thereby better control of columns thus avoiding late collapse and loss of reduction. There were no major wound problems in any of these studies. Weight bearing was started only at 2-3 months which is similar to our study.

In our study, there were no late complications like loss of reduction of fragments and malalignment with unilateral plating for two column and three column fractures.

We have employed conventional surgical techniques through which we had satisfactory results with the standard conventional methods.

Conclusion

CONCLUSION

Treatment of intra articular tibial plateau fractures is still unsolved.

We cannot statistically differentiate the functional outcome between single column, two column and three column fixation in our study and of other studies at midterm follow up. Choice of the approach/implant should be strictly based on the good clinical judgment of fracture pattern, appropriate classification(three column concept) for the column involved, bone quality and intra operative fracture reduction.

The main aim of open reduction and internal fixation include accurate reconstruction of the articular surface with elevation of the depressed bone fragment, bone grafting or bone graft substitute, stable fragment fixation allowing early range of motion and repair of all concomitant ligamentous structures and other soft tissue injuries.

Complication noted in our series are knee stiffness, infection and screw pull out. These complications are mainly noted in high energy injuries (two /three column fractures).

Column based concept classification makes the surgeon better prepared for intra operative and post operative complications and yields better results. The functional outcome is also similar or superior to the studies based on conventional classifications.

LIMITATIONS:

- Our study population was very small comprising only thirty patients. So it is difficult to come for any statistical correlation.
- Our average follow up period was 12.5 months. A long term follow up of five to ten years could have been more significant to study the post traumatic arthritis.
- We studied only functional outcome using Rasmussen score, radiological outcome was not included.

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CASE PROFORMA

CASE NO :

NAME		FATHER'S NAME	
AGE		SEX	
I.P NO		WARD	
OCCUPATION		RELIGION	
ADDRESS		CONTACT NO	

PARTICULARS OF INJURY

DATE OF INJURY: DATE OF ADMISSION:

DATE OF PRE ANAESTHETIC CHECKUP: DATE OF SURGERY:

DATE OF DISCHARGE:

HISTORY:

TYPE OF INJURY: CLOSED/OPEN

SIDE OF INJURY: RIGHT/LEFT/BOTH

MODE OF INJURY:

ASSOCIATED INJURY:

COMORBIDITY:

DIAGNOSIS & CLASSIFICATION:

PREOPERATIVE TREATMENT:

DEATAILS OF OPERATIVE PROCEDURE:

POST OPERATIVE CARE:

FOLLOW-UP

PHYSIOTHERAPY ADVISED:

TIME OF ACTIVITY:

PARTIAL:

FULL:

FUNCTION AT (RASMUSSEN'S SCORE)

6 WEEKS

3 MONTHS:

6 MONTHS:

MASTER CHART

S.No	NAME	AGE	SEX	MODE OF INJURY	SIDE	CLASSIFICATION	COLUMNS FIXED	IMPLANT USED	FOLLOW UP PERIOD	RASSMUSSEN SCORE	COMPLICATION
1.	MUTHAIAH	54	M	RTA	R	LATERAL	LATERAL	LCP	12 MONTHS	28	-
2.	LOGANATHAN	27	M	RTA	R	LATERAL	LATERAL	LCP	12 MONTHS	28	-
3.	GEETHA	35	F	FALL	R	LATERAL	LATERAL	LCP	9 MONTHS	24	WOUND INFECTION
4.	SIMON BALAJI	27	M	RTA	R	LATERAL	LATERAL	'L' BUTTRESS	12 MONTHS	28	-
5.	VEERASAMY	38	M	RTA	R	MEDIAL	MEDIAL	'T' BUTTRESS	15 MONTHS	28	-
6.	GANESAN	45	M	FALL	L	MEDIAL	MEDIAL	'T' BUTTRESS	17 MONTHS	28	-
7.	SIRAJUDHEEN	51	M	RTA	R	MEDIAL	MEDIAL	'T' BUTTRESS	20 MONTHS	28	-
8.	VANITHA	40	F	FALL	R	TWO COLUMN	MEDIAL, LATERAL	LCP , 'L' BUTTRESS	22 MONTHS	25	-
9.	PARAMASIVAM	50	M	RTA	R	TWO COLUMN	POSTERIOR	DISTAL RADIUS 'T' PLATE	6 MONTHS	27	-
10.	RAJESH	35	M	RTA	L	TWO COLUMN	MEDIAL, LATERAL	LCP, 'L' BUTTRESS	15 MONTHS	25	-
11.	ARUMUGAM	45	M	RTA	L	TWO COLUMN	MEDIAL, LATERAL	LCP, 'L' BUTTRESS	16 MONTHS	24	WOUND INFECTION
12.	VINOTHKUMAR	35	M	RTA	L	TWO COLUMN	MEDIAL, LATERAL	LCP, 1/3RD TUBULAR PLATE	15 MONTHS	23	-
13.	AMANULLAH	36	M	RTA	L	TWO COLUMN	MEDIAL, LATERAL	'T' BUTTRESS, K WIRE	18 MONTHS	24	-
14.	ANADHRAJ	48	M	RTA	L	TWO COLUMN	MEDIAL, LATERAL	'T' BUTTRESS, 6.5 MM CCS	12 MONTHS	23	-
15.	SHARPUTHIN	36	M	RTA	R	TWO COLUMN	MEDIAL, LATERAL	'T' BUTTRESS, 'L' BUTTRESS	6 MONTHS	20	KNEE STIFFNESS
16.	KUTTY	30	F	RTA	R	TWO COLUMN	MEDIAL, LATERAL	LCP,6.5 MM CCS	12 MONTHS	25	-
17.	JOHN BRITTO	36	M	RTA	L	TWO COLUMN	LATERAL, MEDIAL	6.5 MM CCS	6 MONTHS	24	-
18.	CHELLAPANDIAN	45	M	RTA	L	TWO COLUMN	LATERAL	LCP	6 MONTHS	24	-

19.	KARTHIK	31	M	RTA	L	TWO COLUMN	POSTERIOR	DISTAL RADIUS LCP	6 MONTHS	25	-
20.	VASANTH	17	M	RTA	L	TWO COLUMN	POSTERIOR ,MEDIAL	DISTAL RADIUS 'T' PLATE	6 MONTHS	24	-
21.	VENKATESAN	40	M	RTA	R	TWO COLUMN	LATERAL	LCP	8 MONTHS	22	KNEE STIFFNESS
22.	DHAMODARAN	40	M	RTA	L	THREE COLUMN	LATERAL	LCP	6 MONTHS	26	-
23.	RAMACHANDRAN	24	M	RTA	L	THREE COLUMN	MEDIAL, LATERAL, POSTERIOR	LCP, DISTAL RADIUS 'T' PLATE,6.5 MM CCS	16 MONTHS	25	-
24.	MOHAN	49	M	RTA	R	THREE COLUMN	MEDIAL, LATERAL, POSTERIOR	DISTAL RADIUS 'T' PLATE, 6.5 MM CCS	10 MONTHS	25	SCREW PULL OUT
25.	RAJU	27	M	RTA	R	THREE COLUMN	MEDIAL, LATERAL	'L' BUTTRESS, 'T' BUTTRESS	20 MONTHS	26	WOUND INFECTION
26.	VIJAYARAGAVAN	40	M	RTA	R	THREE COLUMN	POSTERIOR , LATERAL	DISTAL RADIUS 'T' PLATE, 6.5MM CCS	16 MONTHS	26	-
27.	SUDARAMOORTHY	45	M	RTA	R	THREE COLUMN	MEDIAL, LATERAL	LCP, 'L' BUTTRESS	22 MONTHS	24	-
28.	BAKYA	24	F	RTA	R	THREE COLUMN	LATERAL, POSTERIOR	'L' BUTTRESS, DISTAL RADIUS 'T' PLATE	21 MONTHS	24	SCREW PULL OUT
29.	RAGAVENDRA	36	M	RTA	L	THREE COLUMN	LATERAL	LCP	6 MONTHS	25	-
30.	DEIVASIGAMANI	40	M	RTA	R	THREE COLUMN	POSTERIOR	DISTAL RADIUS 'T' PLATE	7 MONTHS	21	KNEE STIFFNESS